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ABSTRACT

Based on cooperative action of the government and local communities, the Peruvian Rural School System (SERP 71) evolved from the necessity to reconstruct Peruvian schools of the Sierra region after the earthquake of 1970, and from Peru's new educational reform law (1970) which called for an active-dynamic pupil attitude, continuous updating of educational contents and technologies, and organized communal participation in the educational structure. The government and local communities agreed that the government was to provide carpentry, technical assistance counsel and earthquake-resistant parts for new school buildings. In turn, communities were to collaborate in transportation beyond existing highways, prepare the site, erect the structures, and complete the buildings with local materials. Between 1971 and 1977, 6 SERP programmes constructed 519 schools with regionally manufactured prefabricated sections. The design used in the manufacture of school furniture also required cooperative efforts; desks and chairs were assembled by students and community members. Most difficulties encountered in the programme were caused by a lack of accurate analysis of each individual situation. Photographs, tables of programmes developed and comparative costs, maps of the project areas and diagrams of the old and reformed school systems, government and community contributions to the school building programme, alternative space organization possibilities, building assembly techniques and furniture designs are appended. (CM)

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PERUVIAN RURAL SCHOOL CONSTRUCTION SYSTEM

by

Miguel CANGIANO

Division of Educational Policy and Planning

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PERUVIAN RURAL SCHOOL CONSTRUCTION SYSTEM

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Miguel CANGIANO

Miguel Cangiano is an Argentinian architect who has been working as Consultant to Unesco on various Educational Facilities projects in Central and South America.

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AVANT PROPOS

La Conférence Générale de l'Unesco, lors de sa 19e session (Nairobi, Kenya, 1976) a décidé que "la collecte et la dissémination de l'information sur les nouvelles politiques d'éducation pour le renouvellement et la réforme des systèmes d'éducation adaptés aux besoins spécifiques basés sur des situations sociales, économiques et culturelles particulières et qui ont comme objectif la démocratisation des systèmes dans le cadre de l'éducation permanente" (Résolution 1.111 du programme) se situent parmi les objectifs prioritaires de l'Organisation.

Conformément à ce mandat, la Division des politiques et de la planification de l'éducation a entrepris en 1977 la reproduction et la distribution de certains documents techniques, sous le titre général de "Rapports et Etudes ...". Cette série a pour objet de stimuler la réflexion et les discussions portant sur les problèmes courants auxquels doivent faire face les décideurs, les planificateurs et les administrateurs de l'éducation ainsi que les architectes scolaires. La distribution se limite aux professionnels du Siège et hors-Siège, ainsi qu'aux personnels d'institutions gouvernementales ou privées susceptibles de les trouver utiles pour leur travail. Nous espérons que cette série constituera un moyen pour promouvoir et augmenter la communication entre les individus et les institutions concernés par les différents aspects des politiques et de la planification de l'éducation.

Ces "Rapports et Etudes ..." se divisent en deux catégories: (i) les documents qui traitent d'un sujet (numérotés S.1, S.2, etc.) et (ii) les documents qui traitent d'un pays (numérotés C.1, C.2, etc. Les premiers portent sur des sujets tels que les politiques et la législation de l'éducation, les techniques de gestion et de planification, la planification et l'étude des espaces, constructions et équipements éducatifs, la relation entre éducation/travail/emploi, la coopération entre les pays, le rôle de l'éducation par rapport au Nouvel ordre économique international, etc. Les seconds présentent des profils du système éducatif d'un pays donné (principalement les pays les moins développés) ou traitent d'une réforme ou d'un aspect spécifique du système éducatif du pays concerné.

Certains des documents reproduits dans cette série sont des "desk studies" basés sur des informations déjà existantes à l'Unesco, d'autres ont été préparés à l'origine pour servir de documents de base ou de discussion à des réunions ou séminaires, alors que d'autres encore, exprimant les positions personnelles des auteurs, se situent dans le cadre d'un dialogue permanent au sein du Secrétariat de l'Unesco.

Les documents sont choisis pour cette série en fonction de l'actualité du sujet traité. Les lecteurs doivent tenir compte du fait que beaucoup, sinon la plupart, des documents sont des documents de travail inédits et ne sont pas destinés au public. Certains auteurs ont rédigé ces documents dans une langue qui n'est pas la leur, ce qui explique certaines faiblesses linguistiques. Nous voudrions également souligner que les documents expriment les idées de leurs auteurs respectifs et ne reflètent pas nécessairement la politique de l'Unesco.

La Division des politiques et de la planification de l'éducation souhaite recevoir des commentaires ou suggestions au sujet de la série, et demande aux lecteurs de bien vouloir faire part de leurs réactions à certaines idées exprimées ou à des documents dans leur ensemble. Dans certains cas, il sera peut-être possible de reproduire ces commentaires et réactions lors d'une prochaine parution de la série. Les adresses des auteurs des documents sont indiquées afin de donner aux lecteurs qui le désirent la possibilité d'entrer en contact avec eux.

FOREWORD

Unesco's General Conference at its 19th session (Nairobi, Kenya, 1976) resolved that the Secretariat give particular attention to "gathering and disseminating information about new educational policies for the renewal of educational systems, adapted to specific needs on the basis of particular social, economic and cultural situations and aimed at promoting democratization of the systems within the framework of life-long education" (Programme Resolution 1.111).

In line with this mandate the Division of Educational Policy and Planning began in 1977 reproducing selected technical papers and distributing them as a series under the general title: "Reports, Studies ...". The aim of this series is to stimulate reflection and discussion on current issues confronting educational policy-makers, planners, administrators and school architects. Distribution is limited to Unesco officials at Headquarters and in the field, as well as interested technical personnel in governmental and private institutions. It is hoped that this series will promote and serve as a vehicle for increasing communication between individuals and institutions concerned with policy and planning aspects of education.

The "Reports, Studies ..." series consists of two sub-series : (i) papers with a subject orientation (numbered S.1, S.2, etc.) and (ii) papers focusing on a given country (numbered C.1, C.2, etc.). Subject papers deal with such topics as educational policies and legislation planning and management techniques, planning and design of educational space and facilities, the relationship of education to productive work and employment, inter-country cooperation, the role of education in respect of the New International Economic Order, etc. Country papers are either brief profiles of the educational system of a particular country (mainly the LDCs) or treat a specific reform or aspect of the country's educational system.

Some of the papers reproduced in the series are "desk studies" based on information available within Unesco, others were originally prepared as background or discussion papers for a meeting or seminar, while still others are personal position papers representing part of a continuous dialogue within the Unesco Secretariat.

Papers are selected for the series on the basis of their topical interest. Readers should bear in mind that many, if not most, of the papers are working documents, unedited and not intended for public distribution. Some of the authors have written in a language other than their mother tongue, which explains certain linguistic deficiencies. It must also be stressed that the papers present the ideas of their respective author and do not necessarily reflect the policies of Unesco.

The Division of Educational Policy and Planning welcomes comments and suggestions concerning the series and invites readers to make known their reactions to particular ideas presented or to entire papers. In certain cases it may be possible to reproduce such comments and reactions in a subsequent issue of the series. For the convenience of readers who may wish to contact the author of a paper, the current contact address is given whenever possible.

RESUME

Description Générale

SERP 71 est un procédé semi-industrialisé de construction, couplé à un système opérationnel propre, développés par le Ministre de l'Education péruvien en 1971-72 afin de combler le déficit en constructions scolaires des zones rurales de la Sierra péruvienne. Basé sur une action conjointe du gouvernement et de la population concernée, SERP 71 permit de satisfaire les besoins urgents crées par le tremblement de terre de 1970, ainsi que ceux d'autres zones rurales, et de répondre favorablement aux exigences de la nouvelle loi sur la Réforme Educative.

L'accord de collaboration entre le gouvernement et les communes prévoit la fourniture des éléments de structure et la menuiserie par le gouvernement, ainsi que l'assistance technique nécessaire à leur mise en oeuvre. La commune participe au transport hors des routes carrossables, procède au montage sur un terrain préalablement préparé, et assure la finition du bâtiment avec des matériaux locaux. Les éléments préfabriqués sont conçus en fonction de la petite industrie régionale, pouvant être fabriqués, sans avoir recours à des équipement sophistiqués, à partir de matériaux achetés en gros par le gouvernement. 519 écoles furent construites entre 1971 et 1977, ce qui représente 96,426 m^2 couverts.

Le Système de Construction

Le procédé adopté par SERP 71 consiste principalement en une charpente en treillis tridimensionnel fournie à la commune en pièces détachées, laquelle procède au montage de la charpente et la hisse à sa position définitive en la glissant progressivement le long de colonnes tubulaires.

Le module primaire de couverture ainsi obtenu couvre une surface libre de 3.60m x 7.50m dont la juxtaposition, latérale ou frontale, à d'autres modules semblables, permet de satisfaire, par la grande variété de combinaisons envisageables, les nouvelles orientations de la Réforme Educative.

Le Système Opérationnel

L'apport le plus important du projet SERP 71 fut probablement son système opérationnel. Basé sur une approche pragmatique des solutions techniques et sur une répartition sélective des responsabilités aux niveaux national, régional et local, il permit une véritable décentralisation et une réelle participation communautaire.

L'Auteur

Miguel Cangiano est un architecte argentin qui a souvent collaboré avec l'Unesco en qualité de Consultant pour divers projets d'équipements éducatifs en Amérique Latine.

SUMMARY

General Description

SERP 71 is a building and operative system developped by Peru's Ministry of Education during 1971 and 1972 in order to cover the school-building deficit of the Sierra rural areas. Based on a concurrent action of the government and the local communities, it made it possible to attend to the urgent demands of the region devasted by the 1970 earthquake and other rural areas of Peru, and to the new requirements of Peru's Educational Reform.

The terms of the government/local communities agreement were that the government would provide the earthquake-resistant structural parts and the carpentry, along with technical assistance counsel. The community would collaborate in transportation beyond existing highways, prepare the site, erect the structure and complete the building with local materials. Prefabricated elements were made sufficiently simple to be regionally manufactured, with no special equipment, from bulk-purchased materials. 519 schools were built from 1971 to 1977, covering a total of 96,426 sq.m.

The Building System

The SERP 71 system consists mainly of lightweight sub-components to be assembled into a spaceframe roof deck by the community on the site, and then hoisted in position by gradually sliding it up tubular columns.

The resulting space is a 3.60m x 7.50m clear span planning module which can grow both ways (once opposite and indefinitely sideways), providing a variety of spatial solutions capable of satisfying the Educational Reform's Requirements.

The Operative System

The Project's main contribution was perhaps the Operative System based on a pragmatic view of technical solutions which allowed immediate response to urgent needs, and on a selective global, regional and local distribution of responsibilities which obtained an effective decentralization of efforts and encouraged community participation.

The Author

Miguel Cangiano is an Argentinian architect who has been working as Consultant to Unesco on various Educational Facilities projects in Central and South America.

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1. INTRODUCTION

1.1 Background and Definition of the Problem

In 1970 a great earthquake destroyed most of the Peruvian region North Lima, in the Departmentos of Ancash and La Libertad. The destruction of school buildings was estimated at 100% (5,000 classrooms).

The devasted region, specially the Sierra, lacked the necessary technical development in materials and labour force to provide educational buildings quickly and effectively. Access roads were scarce and difficult (unpaved roads going up to 4,300m above sea level) and rural communities were settled on the hills, some of them 1,000m above the main road and only attainable by foot trail (Fig. 1).

A positive counterpart to the difficulties presented by the region was the local indian communities' tradition of mutual help and participation in communal works; this is the most significant antecedent of the SERP experience, whose strategy was developed on the basis of this human resource of an enormous production capacity when serving its own vital needs.

1.2 Educational Reform

Peru's new law of education, embodied in the "Informe General de la Reforma de la Educacion Peruana" appeared towards the end of 1970, establishing new orientations based on an active-dynamic attitude of the pupil, continuous updating of educational contents and technologies, and on an organized communal participation in the Educational Structure (Fig. 2).

1.21 Nuclearization

The Communal Education Nucleus (Núcleo Educativo Comunal), an integrated network of interdependent schools, planned as part of a whole, becomes the basic cell in educational and physical planning. It has enough authority to determine the priority of its needs, including curricula adjustments, depending on the requirements of its influence area.

1.3 Peruvian Rural School System (SERP)

The Peruvian Rural School System was the outcome of the necessity of reconstruction and othe wish for an effective instrument in the field of rural school building to implement the Educational Reform.

The urgency of the problem was as important as the problem itself, and the solution had to respond to this urgency but had to be a lasting one too. The Central Reconstruction Office (CRYRZA) also intended that all reconstruction works should follow the Educational Reform and not repeat what had been done before. Furthermore, the devastated region's situational frame being similar to many other Sierra regions of Peru, the solution proposed should have a wider scope than simply that of the afflicted zone.

2. SERP (Sierra)

2.1 General Ideas

In addition to the general considerations mentioned above, the work-team based itself on the following premises:

a) Traditional methods alone could not solve the problem. On the one hand, no contractor would face the region's difficulties in order to build only small schools (100 to 200 sq.m.). On the other, self-help alone would render execution times very long, technical assistance would be complex and expensive, and

building materials would have to be imported from the coast in order to ensure an efficient technology.

b) The experience of other successful rural school-building programmes in Latin America - in Mexico, in Venezuela, in Chile, etc. - should be tapped to develop a new solution taking into account the new pedagogical contents of the Educational Reform, the productive characteristics of the country and the human resources of the region.

c) The following elements were of capital importance and were to be considered in the proposal:

- The current official encouragement of the people to participate in the changing of social structures.
- A time-honoured communal tradition of direct participation in its own administration and in public works of local interest.
- An incipient but growing industrialization process, specially in the coastal region.
- A popular building tradition, not too specialized, on which most of the "built" physical frame of the region was based.

2.2 Basic Principles

The resultant work hypothesis was to combine the industrial production lines with the regional technological capacity through a process articulated by the active participation of the Communities lacking school buildings (Fig. 3).

Industrial Production could offer: mass produced elements and services, difficult to obtain at a local, artisan production level, such as:

- Independent structure
- Roofs
- Carpentry
- Services
- Adequate quality control
- Short and controlled production terms
- Cost economy through mass production
- Stimulation for industrial development

Local Participation could provide:

- Walls, floors, pavements, ceilings, finishes.
- Assembly of industrialized components, as long as these were designed so that no specialized labour was needed.
- A decentralized action which, being under the future users' control, would have a great probability of success.
- A significant economy through the elimination of the contractor.
- A possibility of integrating the sometimes scattered community effort in a planned regional action.
- The insurance of subsequent maintenance, the school being part of the communal patrimony.

2.21 Pragmatic Outlook

The development of this hypothesis implied a new "modus operandi" in the design conception and in the organization of the works. The idea of operating at a large scale with very centralized industrial production co-ordinated with de-centralized action at each location, involved a new experience and would mean a great effort on the part of the responsible work-teams (office, workshop and field teams). The questions which this option raised could only be answered by assuming concrete actions, risking the margin of error that this implied. More theoretical analyses would only increase the number of questions and reality was demanding immediate solutions, not diagnoses.

2.3 Development Criteria

The development of this principle demanded a series of definitions that would cover the different technical and policy aspects involved:

A) Planning Criteria

Sufficiently accurate information for a regional-level action such as the devastated zone required was not available; the first preliminary plans for nuclearization could only serve as a basis for general diagnossis. Time, however, was critical and lack of accurate infomration had to be considered as one of the

facts of the problem in order to keep going. Basic typical-situation proposals would be prepared, but always with an approximate real value and not as accurate solutions. The system had to be flexible enough to accept changes at any time and to cover a great many possibilities.

It was important to have enough global information to begin industrial production of components for the approximate volume of building required. Each case's specific requirements would be decided at the site-work phase.

The idea of having a stock of building components available breaks the strict correlation between planning design and construction of the usual operative programmes of traditional building. The functional space organization system and the building system should be conceived so that the necessary adjustments could be made once accurate information was obtained.

B) Functional Design Criteria

The lack of accurate requirements for each case and the situation of constant change due to the Educational Reform made it imperative that the functional definitions be reduced to essentials.

The "indoors" educational space would have a capacity of from 20/25 pupils to a maximum of 50 per space unit. Indoor space should be handled as a whole, available for different uses, and it should offer the greatest expansion and combination possibilities compatible with maximum building simplicity.

A series of functional solution prototypes would serve as basic plans to be modified by the Community following the local functional needs.

For the estimation of quantities to be bid, the school building would be defined as the volume necessary for the relevant number of pupils, without going into greater detail. Classroom equipment, and its distribution, would be of great importance for it would have to provide the organization and multiple-use flexibility that the walls would not be able to offer.

C) Building Design Criteria

Functional requirements demanded a flexible indoor space plan with simple expansion possibilities within a range of 6 to 8 meters free space either way and 3 meters high.

The technology employed should not be too specialized so as to be able to use most of the existing resources without further investment and to allow medium-sized regional workshops to participate. The design should also take into account the different modes of component transportation (vehicle and manual) and the differing physical conditions on site which could affect the stability of materials. Assembly of the industrially produced components should require simple, repetitive and safe procedures in view of the local use of unskilled labour.

Existing materials and techniques should be adapted from local technology, striving to improve without imposing an expensive "re-apprenticeship" on the people.

Building solutions should provide a clear answer to the earthquake problem with an economic final cost and with a flexible building organization capable of accepting all the unexpected situations that the operating method would naturally generate.

D) Operative Criteria

As has been said before, a "general-to-particular" operative philosophy imposed itself from the start as being the only one that would allow the project to proceed without waiting for precise data to be gathered on the different aspects of the problem, most of whose detail was unknown and/or in the process of change through Educational Reform.

Three stages were determined for the implementation of the operative system:

a) Study and experimentation of the building aspects at a plan level and laboratory "research" on the principle parts.

b) A small experience of building 5 to 15 schools to ensure a complete survey of the whole cycle.

c) A first large scale project (minimum 50 schools), located in a homogenous area, in order to have a maximum concentration of effort and to obtain valid conclusions.

The success of this "in-production" operative method was finally, in a way, an end in itself and one from which depended the success of the whole operation. Definitive answers only began to appear through the production workshops and the building sites of the first projects.

A Swedish government offer provided the opportunity to build 15 schools as a preliminary field-check of the operative system's implications (Fig. 18).

One of the outstanding characteristics of the SERP programme was the organic and programmed support offered to the community, an investment in human resources capable of assisting in its promotion.

E) Cost Hypothesis

In order to obtain the lowest possible costs and build the maximum number of schools, the following procedures were adopted:

- Large-scale bidding: the larger the numbers, the lower the unit cost.
- Direct purchase from the manufacturer: elimination of intermediaries.
- "Freezing" costs by buying most of the components at the beginning of a project.
- Setting up an Operational Office in the project area to reduce administrative and technical assistance costs.
- Securing the Community's participation.

The maximum estimated cost of the government's contribution in 1972 should not exceed 1,000 Soles/sq.m. (23.25 US $ / sq.m.).

2.4 Description of the Proposed System - SERP 71 - Sierra Type

2.41 Functional and Space Organization

a) Available Space and Growth

The basic volume is defined by a 7.50m x 3.60m clear span rectangular plan with columns in the corners supporting a

single slope roof, sloping along the longer axis. This module can grow sideways in 3.60m increments, keeping the same slope with a 7.50m depth, or it can grow by one unit opposite the roof's slope, creating a "two slope" roof, or both. It is adaptable to different sites and can provide more compact spaces where perimeter economy is required (Fig. 4).

b) The Standard Projects

The technicians' efforts concentrated on the building and operative aspects - not on the functional ones - because the proposal of Educational Reform was still in its general formulation phase; because of its independence from the structure, the "available space" proposal offered the possibility to adapt itself to future definitions of educational uses and techniques (Figs. 5 and 6).

2.42 The Building System

a) The Government's Contribution - Industrialized Components

a.1) The Supporting Structure and Roof Deck

Independent from the enclosing wall, it has a 7.50m clear span with corbels of about 1m. It is designed to support the covering's wind, seismic and gravitational loads, and is demountable for vehicle, animal, or manual transportation. It can be assembled by unskilled labour with no motorized equipment and requires no specialized manufacturing tools. Made of common structural steel, available in the country through its use in reinforced concrete, it conserves its geometrical stability under environmental changes between manufacturing place and school site. Maximum component size for transportation: 4.50m. Maximum weight for manual assembly: 100 kgs.

The roof deck is basically a space-frame formed by very light plane joists first assembled in a folding pattern, then tied to transversal and longitudinal steel angle straps by a simple pressure joint, forming beam chords in both directions. The diagonal triangulation of the joists constitutes the diagonal bracing system. Ring-shaped capitals in the space-frame allow

it to be slid up the round columns until it reaches the required level. All this is done by hand, the weight of the structure being only 8.4 kg/sq.m. (Figs. 7 to 11).

a.2) The Roof Covering

Corrugated asbestos-cement sheet was chosen, easier to maintain than galvanized steel sheet and costing the same price. Perimetral closures were also asbestos-cement, without taking great account of the lack of air-tightness at its meeting points with the structure. The ceiling was considered as non-essential at the time, given the resources available: it could be easily added by the community later on, using local materials.

a.3) Carpentry

Windows: designed on the basis of common steel angles, they were glazed with polyester resin and fibreglass instead of glass - in spite of the greater initial cost - because of the difficulty of replacing broken glass in rural areas.

Doors: the design of the door is integrated with the window design. The door itself is made of timber planks and is assembled to the steel angles of the doorframe on site or at the storehouse.

a.4) Services

Proposals for a simplified electric system and elementary sanitary installations were prepared during the first phase of the programme but were not used later as rural schools generally have no electric supply nor water canalization systems.

a.5) Miscellaneous

The government also contributed with cement for foundations and floors, plaster for the walls and paint for walls and structure.

a.6) Technical Assistance

Technical assistance is provided to the community during the whole building process. Discontinuous during the ground preparation, assembly of components and roof-laying phases, it is more frequent during the flooring, walls and finishing stages.

b) The Community's Contribution - Local Elements of Artisan Technology (Fig. 12)

b.1) Walls

The two systems generally used are adobe and brick masonry. They can also be built in quincha (timber or reed framework, stuffed and rendered with mud). Being independent from the structure, their smaller earthquake resistance was accepted as a working hypothesis, as long as the roof's stability did not depend on them.

b.2) Floors

Sub-floors follow local techniques and the usual finished floor specification is cement screed.

b.3) Handwork

The community also contributes labour force for ground cleaning and levelling, structure foundations, structure assembly and hoisting, fixing doors and windows and the roof covering.

2.43 The Operative System

The operative system never had, at a system level, a predetermined model. Once the general features were determined, the most adequate strategy would be defined for each programme.

Taking SERP CHASQUI I as a guideline, the operative system can be described as follows:

There were three operating levels: the Ministry of Education in Lima, where the research team worked, a regional centre (Huaraz) where the Project headquarters and component storehouse were located, and the Communities where the schools sites were. A field team provided the necessary operational link between the last two levels (Figs. 13 and 14).

Bidding, transportation and erection documents were prepared, some from the beginning, others during the development of the first programme:

a.1) for the acquisition, manufacture and quality control of prefabricated components

a.2) materials specifications and basic finishing schedules for the traditional or complementary works

a.3) assembly charts showing the location of materials and components

a.4) for site-work activities: assmbly handbook, finishing handbook, typical project plans, progress schedule and typical agreements to be passed with the Communities.

2.44 Classroom Equipment

The same idea of participation guided the design of a furniture system that could be assembled by the children and the Community, eliminating also the problem of transporting "finished" furniture. The basic principle was a structure of plywood plane elements assembled together by a system of pins and grooves. The furniture was designed so that each piece could serve for children of different sizes, by a simple variation of its position (Figs. 15 and 16). Although a complete furniture system was designed, in practice only the desks and chairs were used. In SERP CHASQUI I (16,500 pupils) the cost per pupil was 14 U.S. $.

2.5 Costs

On-site government contribution costs for SERP CHASQUI (1972-73):

Structure	9.83 US $ - m^2	62 %
Roof covering and lateral closures	2.06	13
Doors and windows	2.38	15
Materials for foundations and floors	1.11	7
Miscellaneous	0.47	3
	15.85	100

Final building cost, including estimate of the Community's contribution: 27.95 US $ - m^2. During the same period, traditionally built schools costed 37.21 US $ - m^2, not including water and electrical installations (which were not furnished in the SERP CHASQUI programme). SERP CHASQUI furniture (desk and chair) amounted to 70% of the cost of current furniture in 1973.

3. PROGRAMMES DEVELOPPED 1972-1977

Six programmes were developped between 1972 and 1977, totalling 96,426 sq.m., as shown in Table I (see also Figs. 17, 18, 19 and 20).

3.1 SERP CHASQUI I

Located in the region struck by the 1970 earthquake, SERP CHASQUI I was carried out from 1972 to 1974 and produced 301 schools (62,700 m^2) serving 28,500 pupils per shift. Total cost was 29.95 US $ - m^2 including the Communities' contribution, estimated at 19%.

3.11 Operative Systems

Large scale component bidding was organized by separate items on a public offer basis. All components were produced in Lima except for the carpentry manufactured in Huaraz. Components were delivered at the storehouse in Huaraz; from there the Programme took them by truck to the point where the road ended, from which the Communities took over on horseback or by hand.

A Programme technician assisted the Community in component assembly, roof covering and fixing of carpentry. An 8-module structure required 10 men full time during five days, plus 30 men for hoisting up the roof. A site supervisor provided by the Project assisted the Community with finishing work which, for the same school, needed 6 men full time during 45 working days. Walls were made of adobe rendered with plaster, or of brick. Both the adobe and the bricks were bought by the Community.

Project technicians were from the beginning in charge of Community promotion, as this simplified the Community's view of the Programme. The SERP agent dealt with the Community leader who then co-ordinated actions with other members of the Community. Community reaction and collaboration were very good.

The Project's technicians, located in Huaraz, modified or prepared new projects in terms of the relevant programme and site characteristics. Only 258 schools were provided with desks and chairs, in accordance with their average student attendance patterns.

3.2 SERP CHASQUI I (2nd Phase)

After completion of the first stage, the Project's management started its own production of components. A workshop was installed in Huacho to attend the western watershed of the affected zone. This experience proved the simplicity of the technology required by the system and encouraged ORDEZA* to continue using it. Forty (40) schools were built in this second phase, covering a total of 7,425 m^2 and serving 3,375 pupils. Cost per sq. m., including the Communities' contribution was 35.92 US $. (The government's part amounted to 27.89 US $ - m^2.)

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* ORDEZA: Regional Office for the Development of the Affected Zone.

3.3 SERP CHASQUI II-III-IV

This programme covered Huancavelica, Ayacucho and Apurimac and was carried out in 1973 and 1974, building 101 schools (13,680 m^2) serving 6,300 pupils per shift. Estimated cost: 40 US $ - m^2 (government's contribution: 30 US $ - m^2).

3.31 Operative System

This project was planned on the basis of SERP CHASQUI I experience. The information at our disposal allows us only to indicate a few of its characteristics.

- The programme did not take into account the differences that existed between a project fragmented in three regions and the centralized CHASQUI I.
- The regions were too far away from the production centre. (Bidding was called at a central level and furnishers were therefore from Lima.) Component transportation was further complicated by the rainy season.
- The operative team's implementation was reduced without considering that this type of operatives are very efficient and that operation costs are not proportional to the investment.
- The regional administrative mechanisms were not used to autonomous operation of this type and often lacked the necessary agility.
- The Project had great difficulties in finishing within the programme costs and, followint component transportation problems, some schools were finished with local methods.
- It must be noted that the Communities' enthousiasm diminishes when the field team cannot attend to them continuously and when the component supply schedules are not kept.

3.4 FRONTIER PROJECTS F1 AND F4

Located in Piura, Tacna and Puno, these projects were carried out from 1974 to 1976. F1 built 22 schools totalling 3,300 m^2 (1,500 pupils), at 98 US $ - m^2 all inclusive. F4 built 25 schools adding up to 4,785 m^2 (2,175 pupils) at 176 US $ - m^2.

3.41 Operative Systems

These projects followed the same criteria that governed CHASQUI II, III and IV. They therefore suffered from the same operative deficiencies. Moreover, physical conditions - specially climate - were severe.

- In Puno (4,000m. above sea level) the communities are distant, of difficult access, and have a minimum-subsistence economy. Building materials had to be brought from other places at great cost.
- In Piura (tropical zone) the Community's co-operation was minimal and very difficult to obtain because most of the people had paid jobs and no free time for the Community works.
- It is very difficult to evaluate absolute costs even while keeping a constant exchange value to the dollar, as building costs had remarkably increased.

3.5 SERP PROJECT (ORDEZA)

Located in the region devastated by the 1970 earthquake (Trujillo, Huari and Huacho) and lasting from 1976 to 1977, this project built 132 space modules (estimated at 30 schools) totalling 4,356 m^2 at a cost of 26 US $ - m^2 for the government's contribution.

3.51 Operative System

The importance of this project is that the structure and carpentry components were manufactured in a SERP workshop similar to the CHASQUI I (2nd Phase) workshop.

- Workshop equipment is very simple (soldering, shear, bench drill), and with 13 men it can produce 3 modules every 15 to 20 days. Costs and efficiency not being systematically controlled, it is difficult to establish accurate comparisons.
- Production lines are not too standardized since components are not stock but are inidvidually prepared for each school.
- Budget reduction, constantly rising cost of materials (the dollar's exchange rate tripled from 1974 to 1978) and the diversity of locations to be served show why this operative system tends to be replaced by methods which, though less efficient as to security and velocity, involve a drastic reduction of the government's contribution (artisan techniques with skilled labour assistance under the direction of the Community).

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3.6 TABLE I

PROGRAMMES DEVELOPED BETWEEN 1972 AND 1977

	SERP CHASQUI I	SERP CHASQUI I - Cont.	SERP CHASQUI II-III-IV (a)	F1 (a)	F4 (a)	SERP ORDEZA (a)	TOTAL (a)
No. of schools	301	40	101	22	25	30	519
No. of Modules (33 sq.m./each)	1,900	225	420	100	145	132	2,922
Built sq. meters (a)	62,700	7,425	13,860	3,300	4,785	4,356	96,426
No. of Classrooms (a)	950	112	210	50	73	66	1,461
No. of Pupils per Shift (a)	28,500	3,375	6,300	2,500	2,175	1,980	43,830
Government's Contribution (S/m2)	977	1,199	1,400	1,849	2,148	1,641	
Costs ($/m2)	22.95	27.89	30	41	47.70	24	
Total Cost including (S/m2)	1,202	1,544	1,722	2,000	3,600	2,018	
Community's Contribution ($/m2)	27.95	35.92	40	44.4	80	29	
Total Cost per Pupil (S/p)	2,644.40	3,397	3,788	4,400		4,416	
($/p)	61.50	79	88	98		64	
Year	1972-73	73-74	73-74	74-75-76	76-77		
Dollar Exchange (Soles)	43	43	43	45		69	

(a) Approximate values.

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4. FINAL ASSESSMENT

The SERP experience has significantly grown over the last five years. Comments on it range from praise of SERP CHASQUI I, to total rejection based on cost considerations. Critics overlook the fact that SERP is merely an instrument for a problem solving policy based on Community participation. In other words, SERP is a composite tool, like a lever; it is no use to employ a lever as a rod when one lacks the fulcrum, it isn't half as effective. The excellence of a system depends substantially on its flexible application potential but, being an instrument, it depends as much - if not more - on intelligent and adequate use.

Future development should extend the system's possibilities of adapting to different situations; the operative system should be decentralized so that those who have the problem may be nearer to those who can help them solve it. This can be done through the Nucleus or Zonal offices and through the Regional Directions.

It is necessary to go back to origins and to intensify the philosophy of united action between the government and the Communities.

Information gathered in 1978, after the completion of these programmes is summarized in the following comments, covering the various aspects of the Project.

4.1 Planning

Some communities seem to have exagerated enrolment figures in order to get more schools or more school area built. Some schools with few pupils are relatively near to each other. The use of these buildings will have to be reorganized to avoid waste.

4.2 Functional Aspects

- Furniture - generously designed - sometimes occupies too much space and cannot be properly used. Tables can only be used in a traditional "frontal" way because of their "desk" design.

- The most important criticism lies in the lack of an acoustic barrier between rooms. The system was designed after the Educational Reform's intentions, fostering a new and different use of schools; spaces originally planned "open" have later been subdivided into traditional classrooms. These divisions, however, cannot fully separate the rooms as the ceiling, considered optional, was originally omitted.

- The schools are locked up during the summer holidays as the teachers, who have the keys, don't live in the village. Intensive Community use is therefore impossible, contrary to the Educational Reform's principles. Where the schools have several buildings, one of them could be affected to keep valuables locked and the others left open.

4.3 Building Aspects

- Structure: no major problems.

- Roof Covering: generally in good condition. In windy regions the lack of airtightness of the perimetral closure allows wind to submit the covering to a vibrating stress which has sometimes resulted in hook fatigue and some plates are loose. Original roofing sheets were specially dimensioned to obtain perfect structural coverage. They are now difficult to find in the market when they need to be replaced.

- Perimetral Closure: most criticized point. The proposed closure is not in itself a perfect solution; its wire fixing is often not carefully done and sometimes it doesn't even exist. This becomes an easy access for intruders where the "optional" ceiling was never built. It seems that this detail hasn't been modified in Puno, in spite of the severe cold.

- Walls: brick walls presented no problems. Plaster-rendered adobe, specially gable walls, less protected by the eaves, have suffered in rainy areas like Puno or Piura. Paint is no good: it is not part of the Communities' tradition and they have more important needs to attend to.

- Floors: smooth cement screed proved good except for the very cold highland and plateau.

- Maintenance: no maintenance has been carried out at a teacher, pupil, or Community level, in spite of the fact that more often than not only labour and no buying of materials is required. In spite of complaints about lack of airtightness, not one Community has built a ceiling using local materials (perfectly feasible); the same goes for the perimetral closures. A minimum maintenance programme is essential.

4.4 Operative System

The success of SERP CHASQUI I, the first project developed, was mainly due to the region's resources potential, the careful adjustment of the operative system to local conditions, the well equipped administrative decentralization and to the work team's enthusiasm. Later, less effective programmes based on this success show that each project must be assessed in terms of its own context and that SERP is basically an idea for action and not a recipe.

4.5 Programme Administration

A capital point. Equipment and human resources were considerably reduced in function of the later programmes' diminishing scope. This is neglecting the fact that effectiveness depends on a minimum operative structure to ensure its efficiency. A minimum figure of 50 schools has been recently advanced as a lower threshold to ensure productivity.

The Community's participation and organization capacities depend on its production structures: in Piura most of the people had paid jobs and little free time to help. In Puno (altitude 4,000 m) the Communities' dispersion and access problems are significant, subsistence surplus is practically null and subsistence cattle-raising demands continuous attention. A programme leader stated that a food programme was indispensable to obtain their interest and participation. These two cases prove the need for more than one operative system. It is no use to apply plans valid for other situations.

4.6 Administrative Effectiveness

Most problems were caused by the distance from the Ministry's headquarters in Lima (where components were manufactured) and which was not overcome by adequate planning and co-ordination as in SERP CHASQUI I.

Summarizing, these difficulties stem from a lack of accurate analysis of each individual situation, rather than from any defectiveness in SERP's general proposal.

The biggest problem to solve lies in the degree of decentralization and autonomy that this type of project requires.

SERP CHASQUI I's success was due, to a large extent, to enthusiasm springing from urgency which allowed to overcome bureaucratic inertia in the first projects. These are exceptional conditions which cannot endure within a non-urgency framework. A different, minimum, organizational frame would have been required to ensure a long term development of these ideas.

4.7 Costs

An evaluation of costs must take into account Peru's repeated devaluation of the Sol:

1972: 1 U.S. dollar = 43 soles
1976: 1 U.S. dollar = 69 soles
January 1978: 1 U.S. dollar = 130 soles

It is, however, clear that CHASQUI I, II, III and the Frontier Programmes' significant cost increases were mainly due to their dispersed characteristics and to improper operative choices. Nonetheless, if SERP ORDEZA's costs are compared to those of CHASQUI I, we find that the government's contribution has increased by 13%, far less than the sol's devaluation. SERP ORDEZA's programme structure is similar to the original programme. The apparent economy could be due to the direct production of components.

This short cost analysis indicates that the subject should be studied in depth before assessing SERP on a cost basis.

The SERP system was born as a short-term answer to massive requirements and it tried to establish a pattern of Community promotion based on a mutual engagement between the Communities and the government. If these objectives are not kept its force decreases, specially if no effort is made to adapt to new global situations.

4.8 Table of SERP Comparative Costs

(See following page, Table II)

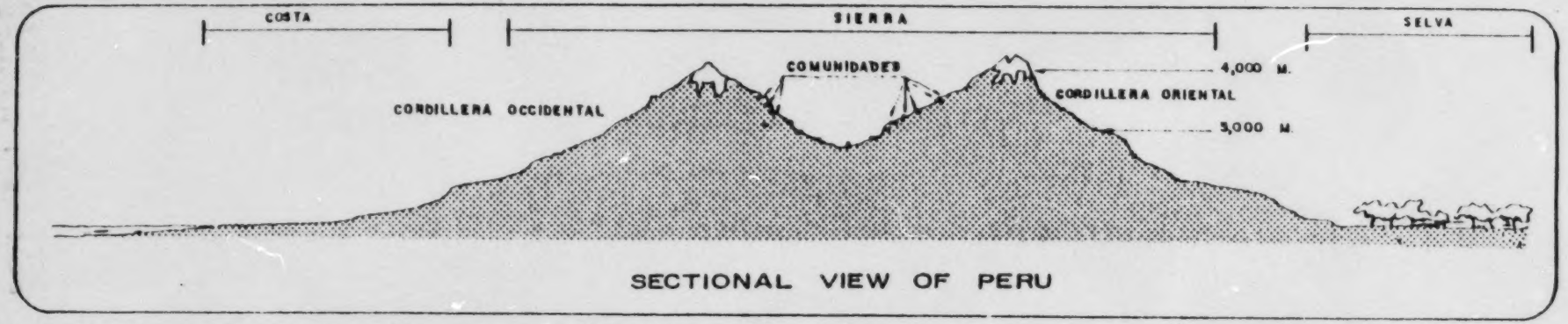
4.8 TABLE II

SERP PROGRAMMES - COMPARATIVE COSTS

Programmes:	CHASQUI (1)	CHASQUI (2)	CHASQUI 2,3,4	FRONTIER 1	FRONTIER 4	ORDEZA
Year	72/74	73/74	73/74	74/75/76	74/75/76	76/77
Total Cost:						
Soles / sq.m.	1,202	1,544	1,722	2,000	3,600	2,018
Dollars / sq.m.	27.95	35.42	37.88	46.5	83.72	32
Government's Contribution:						
Soles / sq.m.	977	1,199	1,400	no data	no data	1,641
Dollars / sq.m.	22.97	27.89	30			26
Variation Total Cost	1	1.28	1.35	1.66	2.99	1.14
Variation Government's Contribution	1	1.21	1.30	-	-	1.13

Note: It is difficult to obtain accurate information on traditional building's real cost values in order to compare them. In 1972 the estimated cost of conventional works, without including service systems was of 37.21 Dollars / sq.m. This cost, referred to the SERP's Government's Contribution involved a 62% greater cost.

GRAPHIC DATA



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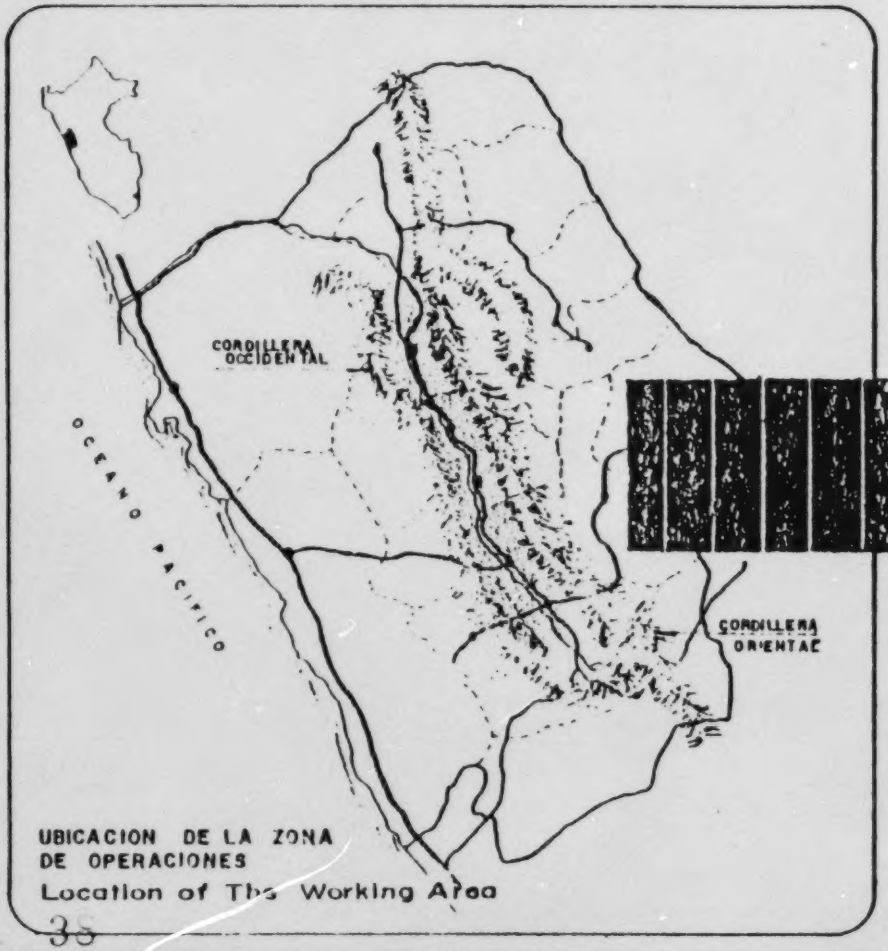
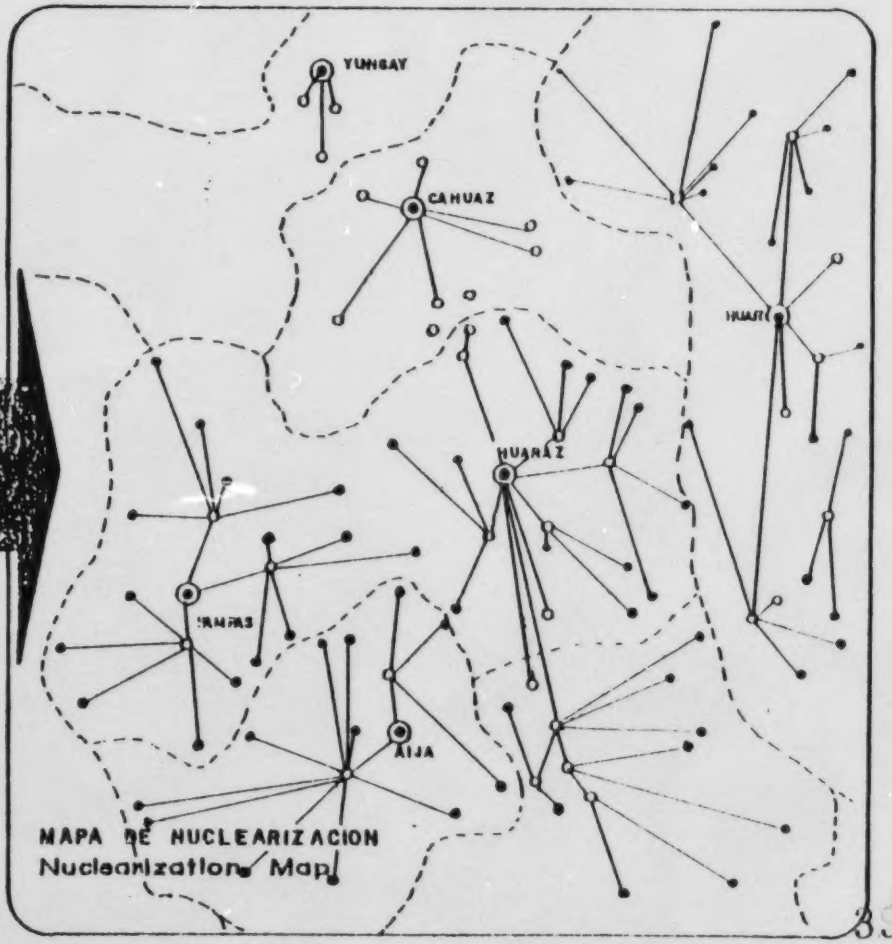


UBICACION DE LA ZONA DE OPERACIONES
Location of The Working Area



MAPA DE NUCLEARIZACION
Nucleanization Map

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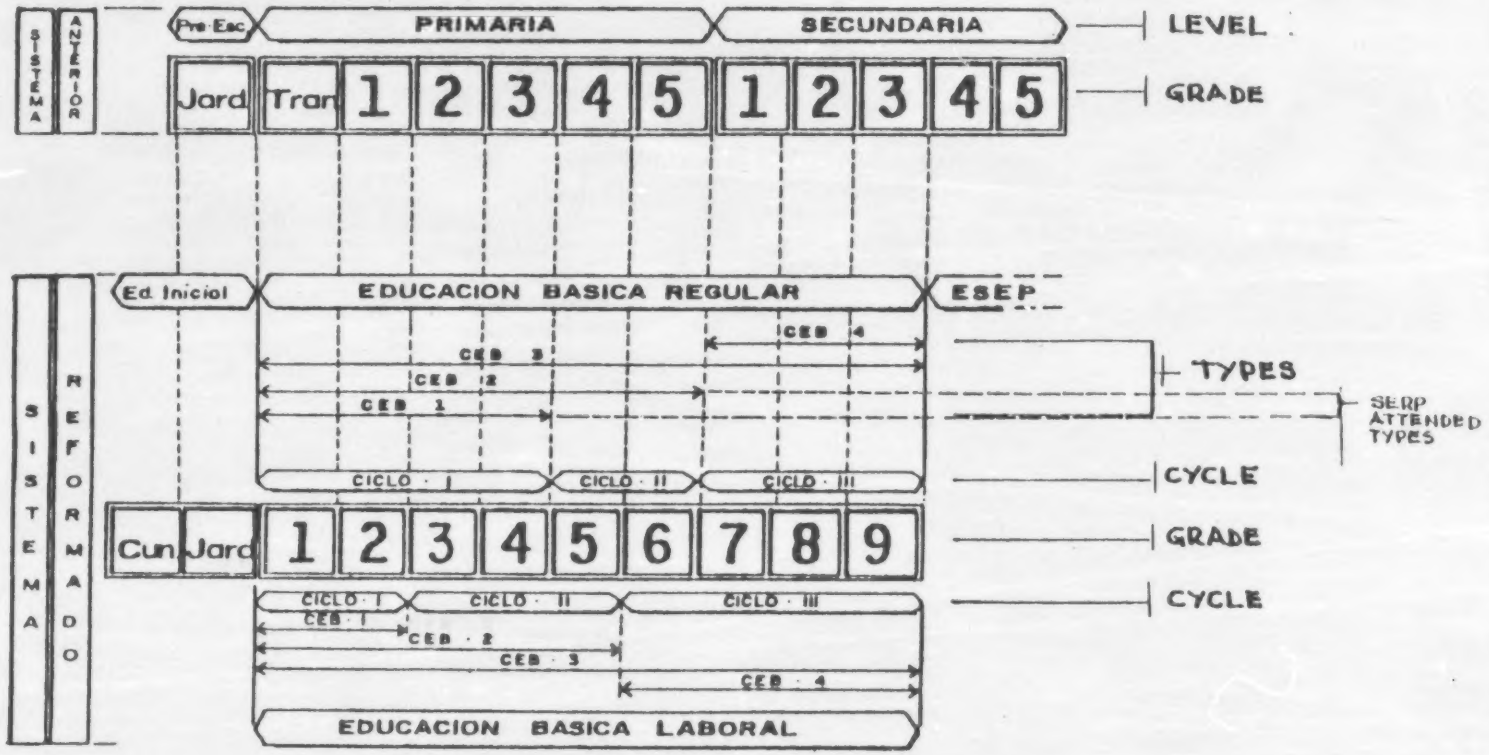
F.1

SISTEMA EDUCATIVO | CUADRO Nº 6

RELATION BETWEEN THE OLD SCHOOL SYSTEM AND THE REFORMED SYSTEM

CUADRO DE CORRESPONDENCIA DEL SISTEMA ANTIGUO CON EL SISTEMA REFORMADO



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STATE PARTICIPATION

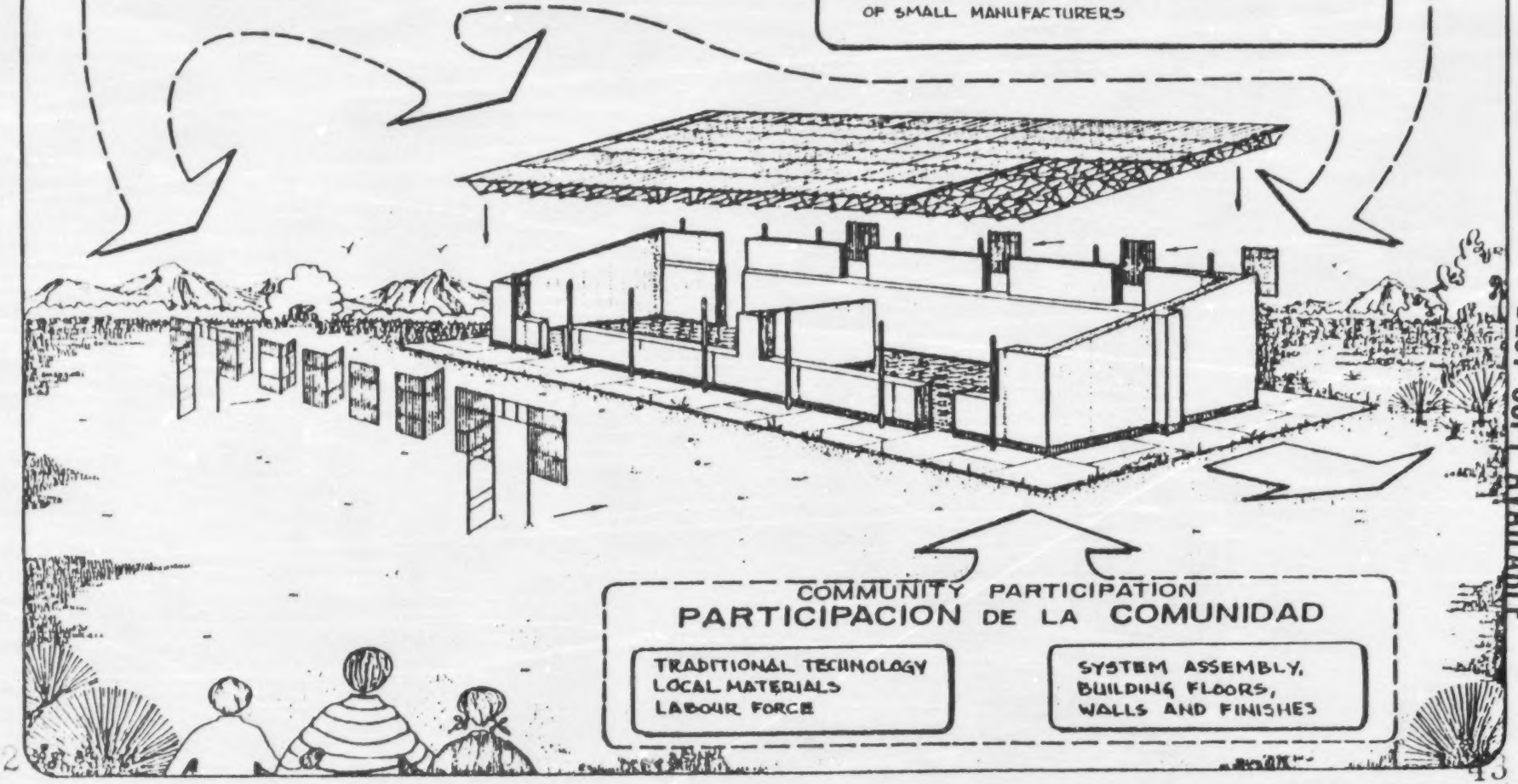
PARTICIPACION DEL ESTADO

WITH:

- PREFABRICATED COMPONENTS (STRUCTURE, DOORS, WINDOWS) OF EASY TRANSPORTATION AND ASSEMBLY
- EFFICIENT TECHNOLOGY
- TECHNICAL ASSISTANCE

IMPLYING:

- LARGE SCALE PRODUCTION
- SERVING INACCESSIBLE AREAS
- QUALITY CONTROL
- LOWER TECHNICAL ASSISTANCE COSTS
- COMMUNITY PARTICIPATION TO ITS OWN DEVELOPMENT
- DECENTRALIZED GROWTH OF SMALL MANUFACTURERS



COMMUNITY PARTICIPATION

PARTICIPACION DE LA COMUNIDAD

TRADITIONAL TECHNOLOGY
LOCAL MATERIALS
LABOUR FORCE

SYSTEM ASSEMBLY,
BUILDING FLOORS,
WALLS AND FINISHES

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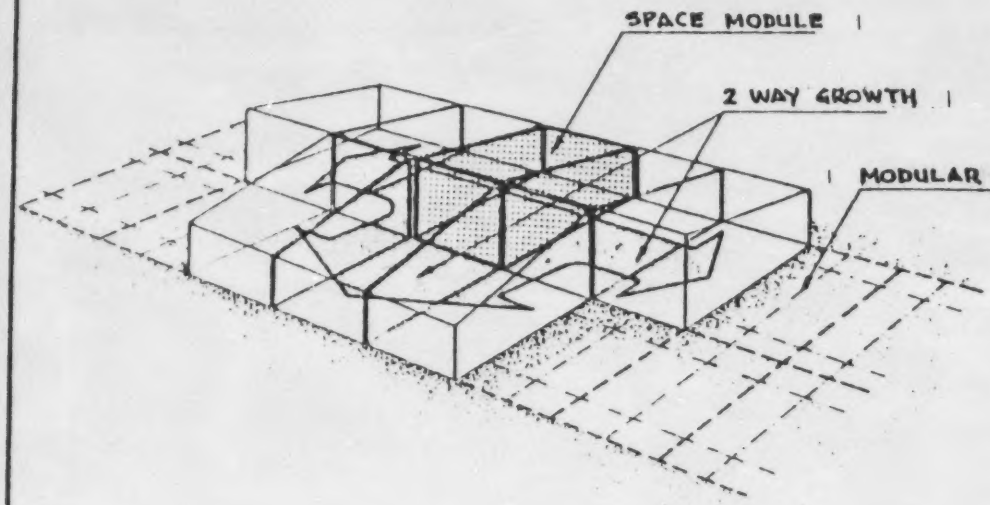
F.3

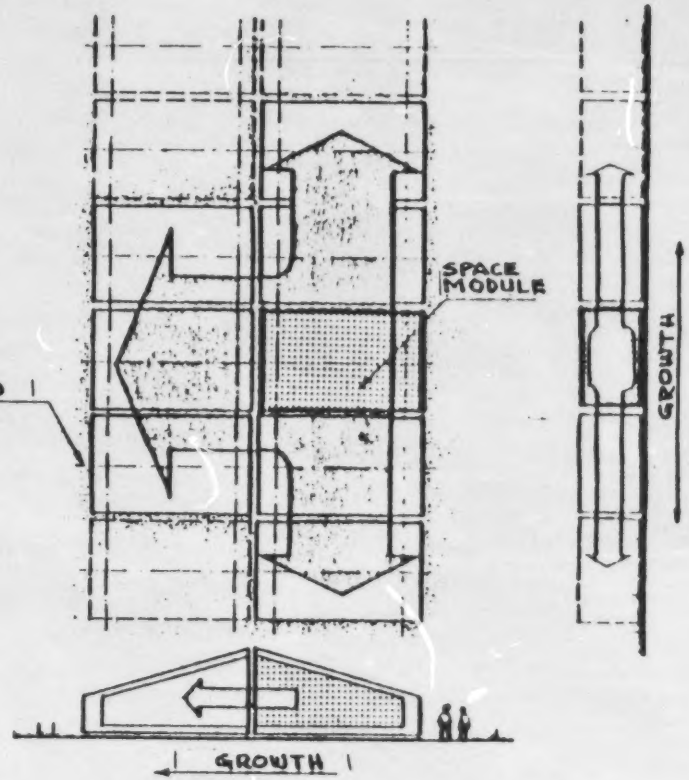
SERP SYSTEM (SIERRA TYPE)

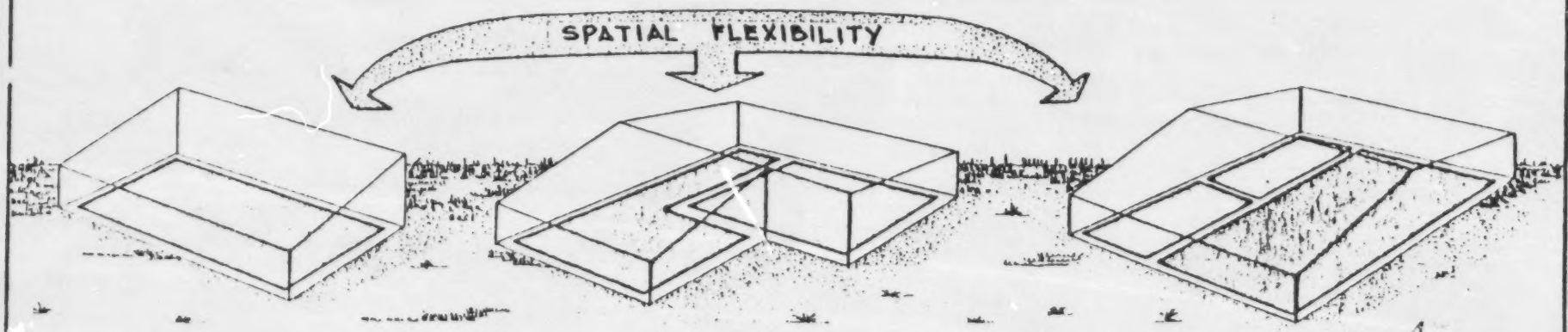
SISTEMA SERP (TIPO SIERRA)

POSIBILIDADES DE ORGANIZACION ESPACIAL

SPATIAL ORGANIZATION POSSIBILITIES







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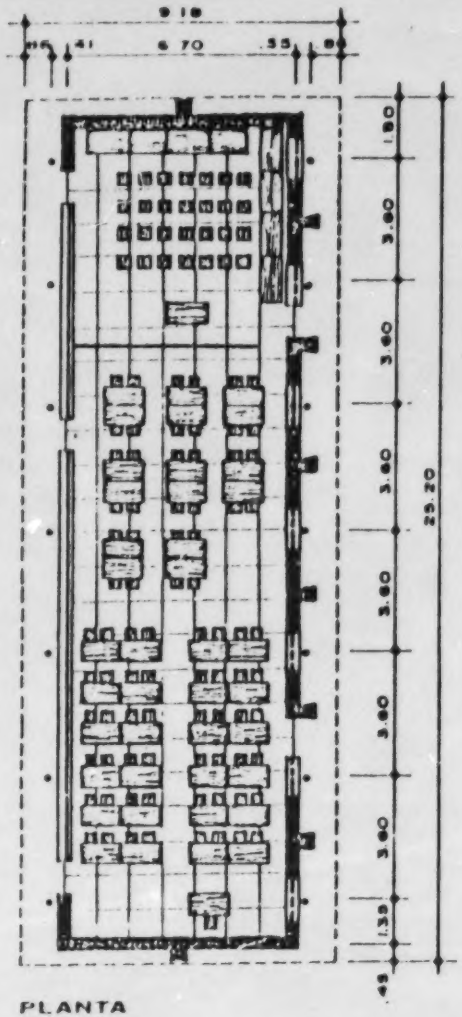

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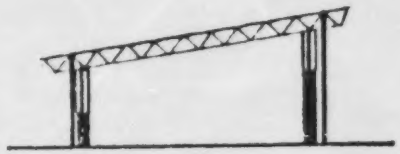

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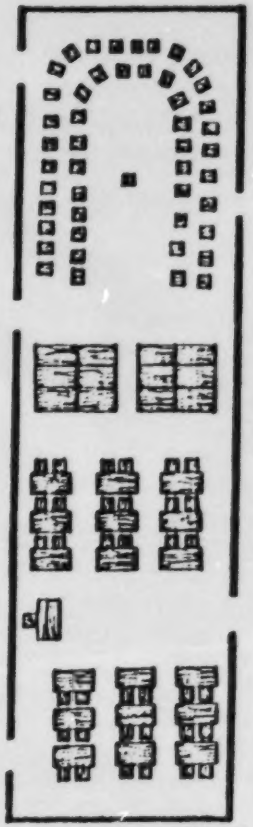

ALTERNATIVE
ALTERNATIVA

STANDARD PROJECTS

Nº ALUMNOS	75 - 125
- AREA TECHADA	231.00 M2
- AREA NETA AULA	150.00 M2
- AREA CIRCULACION	43.00 M2
- TOTAL AREA UTIL	193.00M2

SERP - SIERRA S - 7

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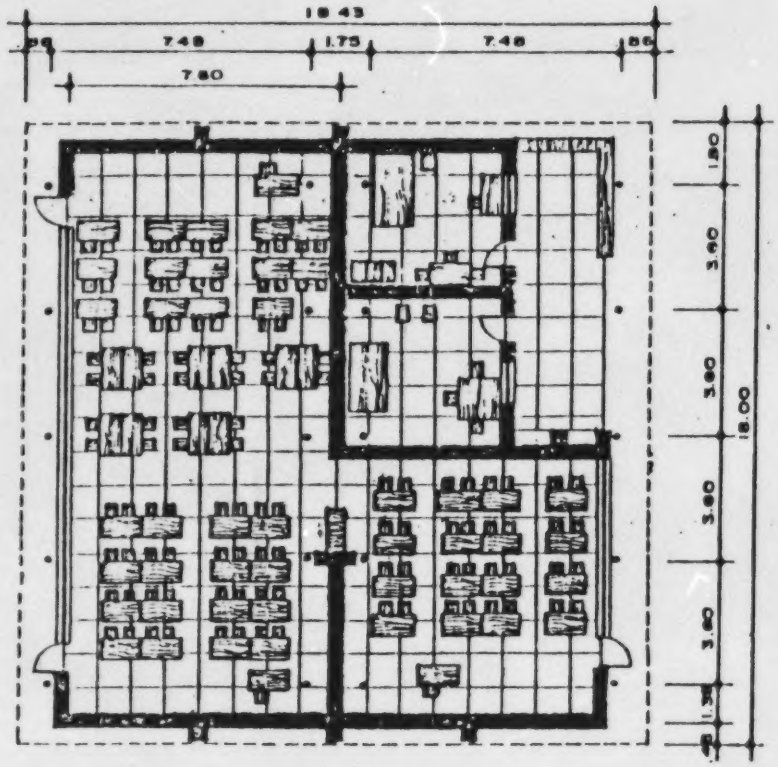

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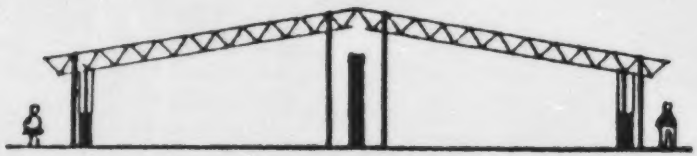

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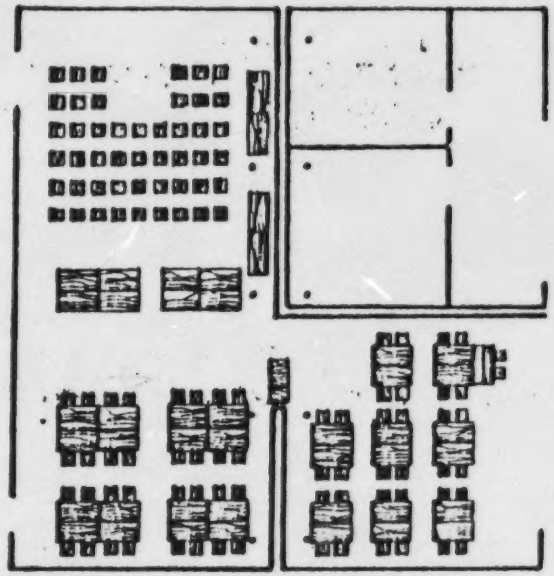

ALTERNATIVA

STANDARD PROJECTS

Nº ALUMNOS	66 - 110
- AREA TECHADA	330.00 M2
- AREA NETA AULA	133.00 M2
- AREA VIVIENDA	58.00 M2
- AREA TECHADA-CIRC.Y EXP.	51.00 M2
- TOTAL AREA UTIL	242.00 M2

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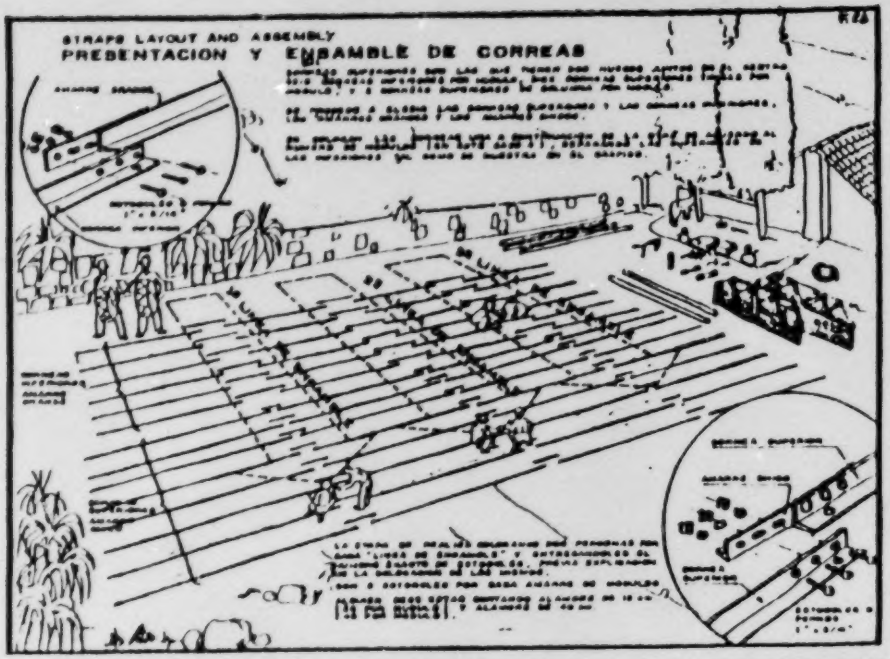

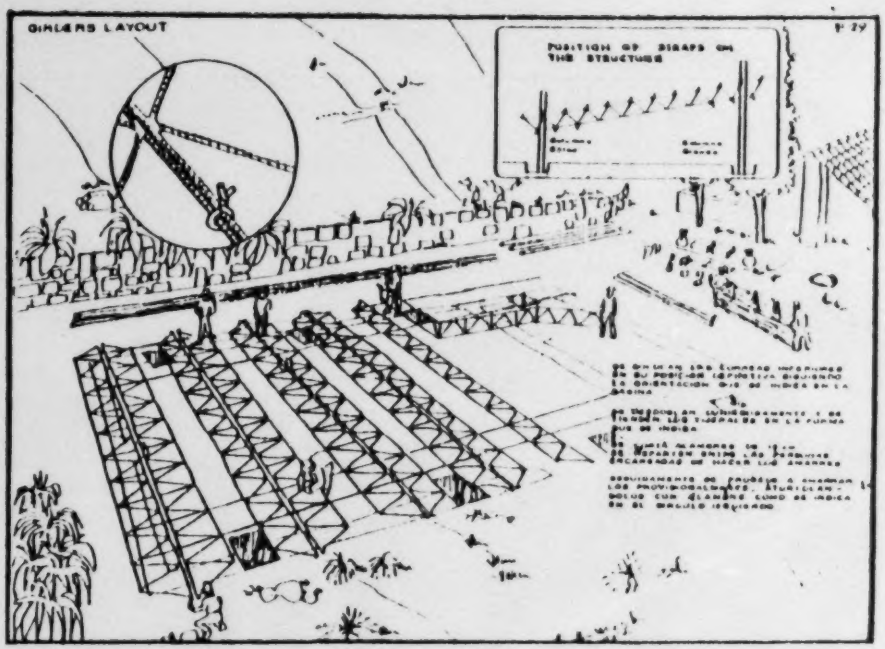

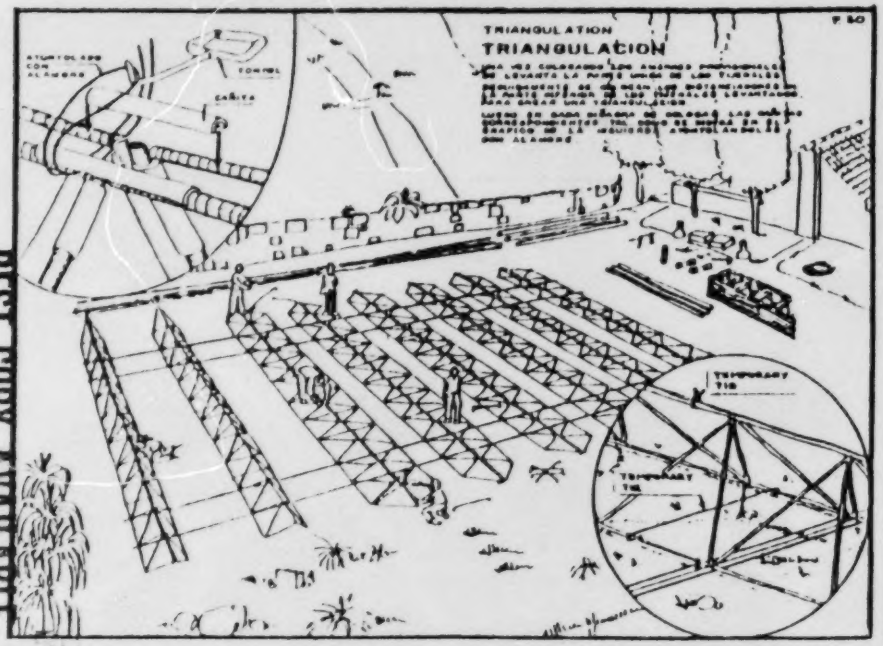

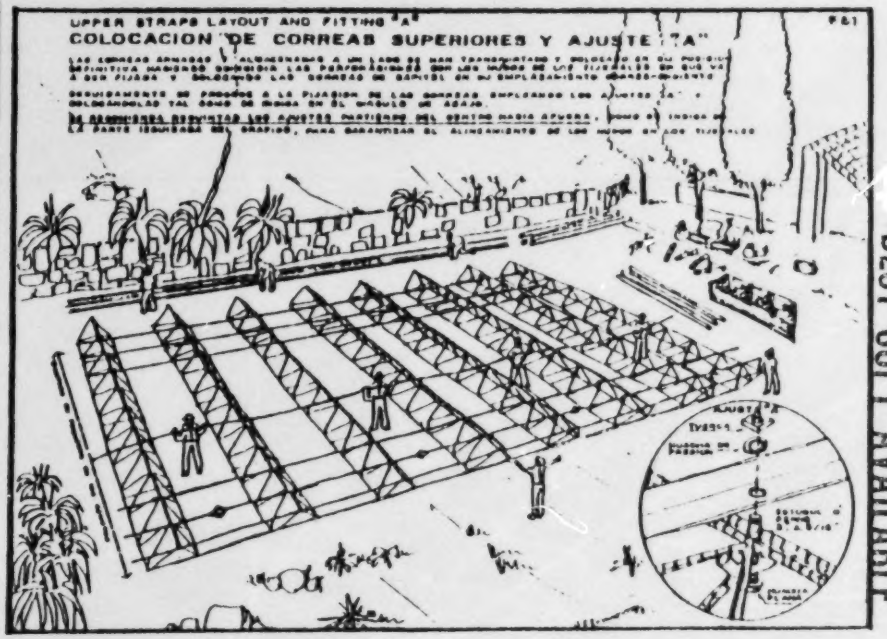

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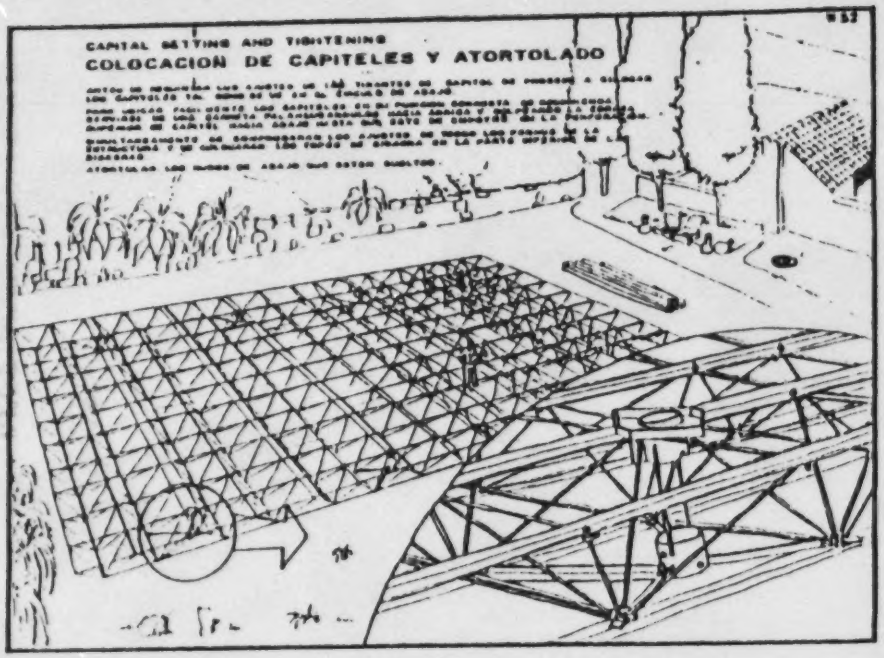
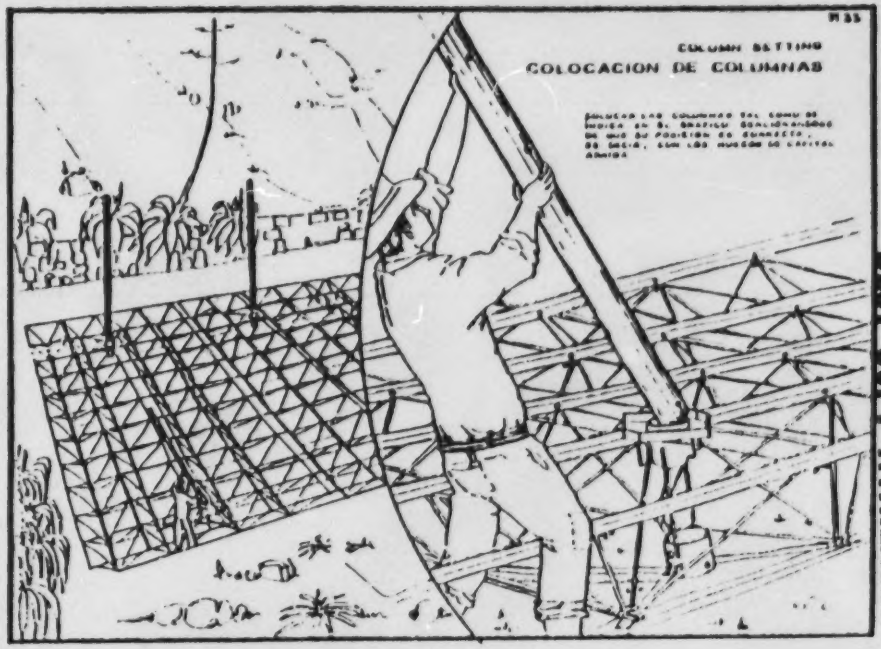
CAPITAL SETTING AND TIGHTENING

COLOCACION DE CAPITELES Y ATORTOLADO



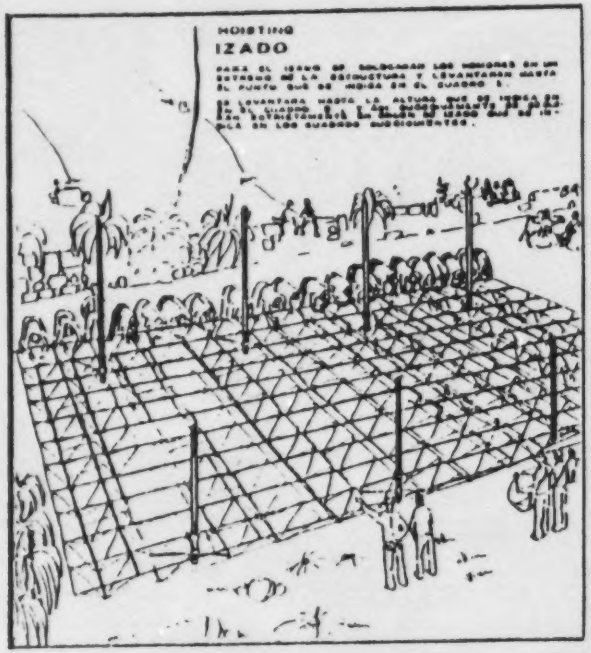
COLUMN SETTING

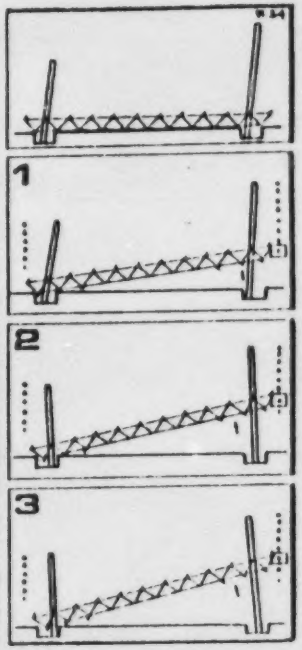
COLOCACION DE COLUMNAS



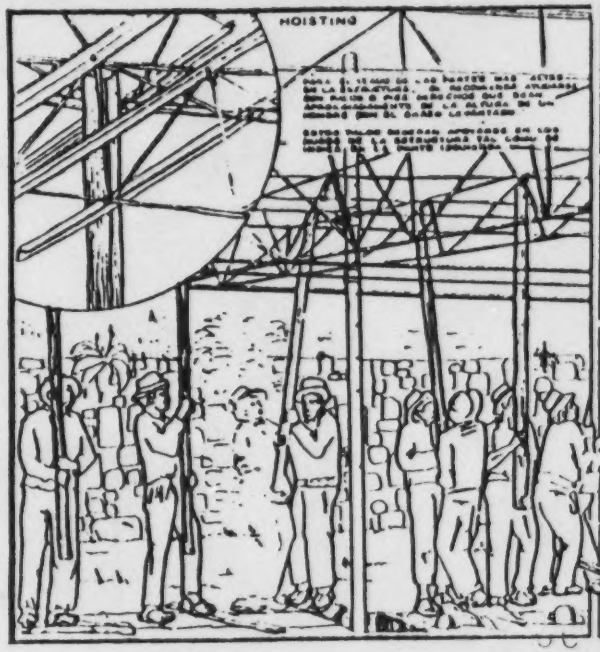
HOISTING

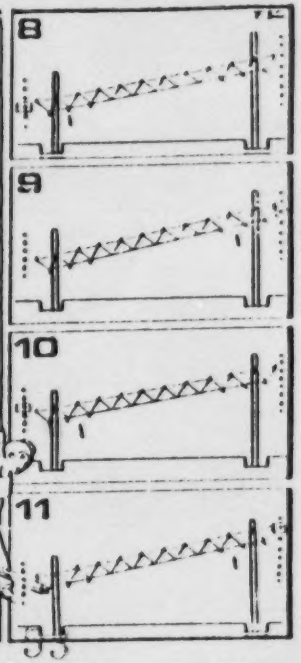
IZADO





HOISTING





F.8

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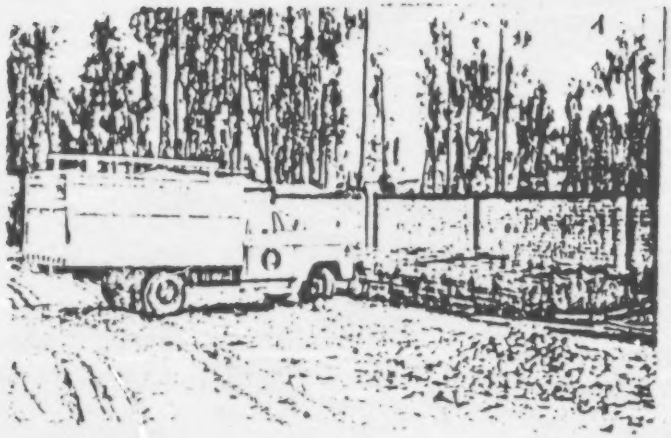
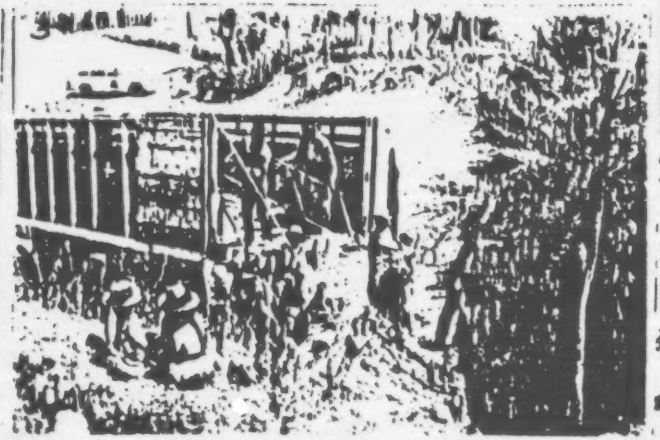
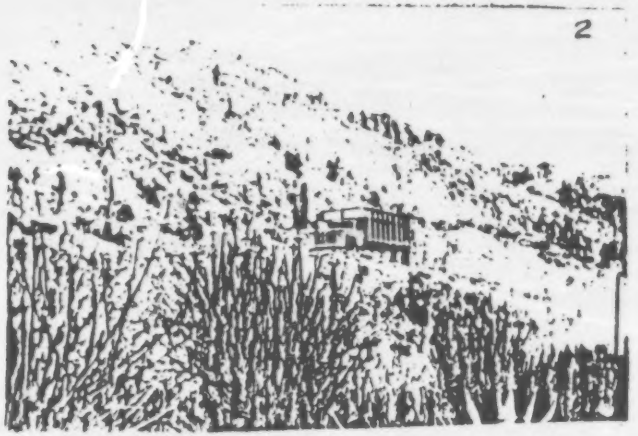
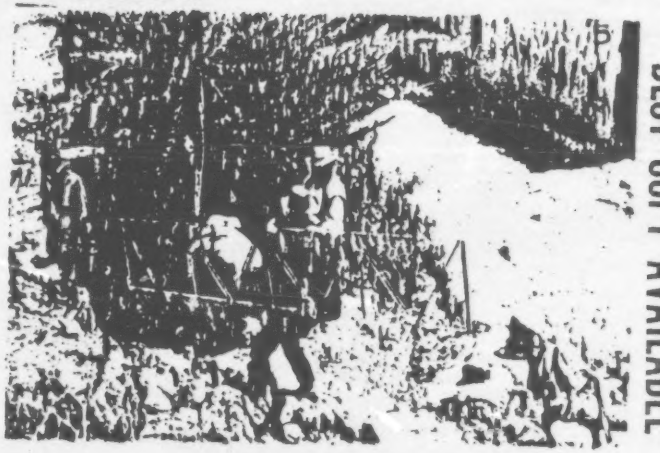
TRANSPORTE A LA COMUNIDAD
TRANSPORTATION







1. CARGA EN ALMACEN.
2. TRANSPORTE AUTOMOTOR.
3. DESCARGA.
4. 5. TRANSPORTE AL "HOMBRO" POR CAMINOS DE HERRADURA.



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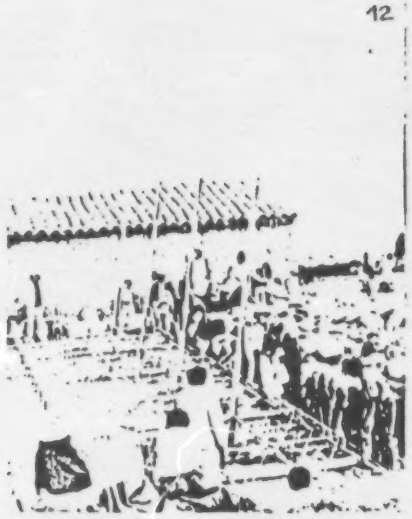

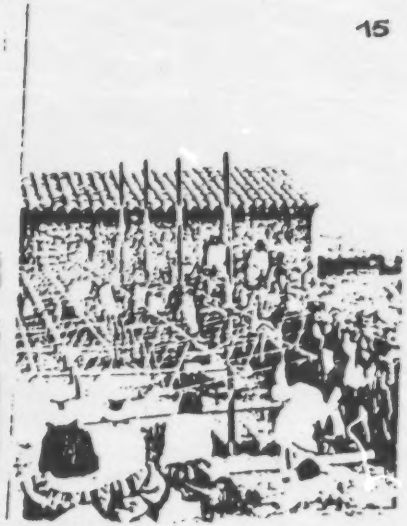

ARMADO...

SECUENCIA DEL IZADO

STRUCTURE BUILDING

HOISTING

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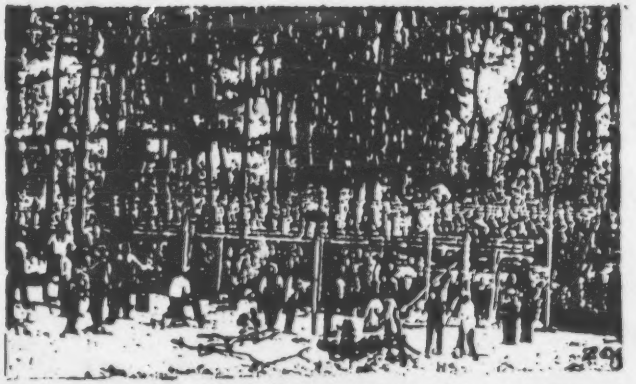
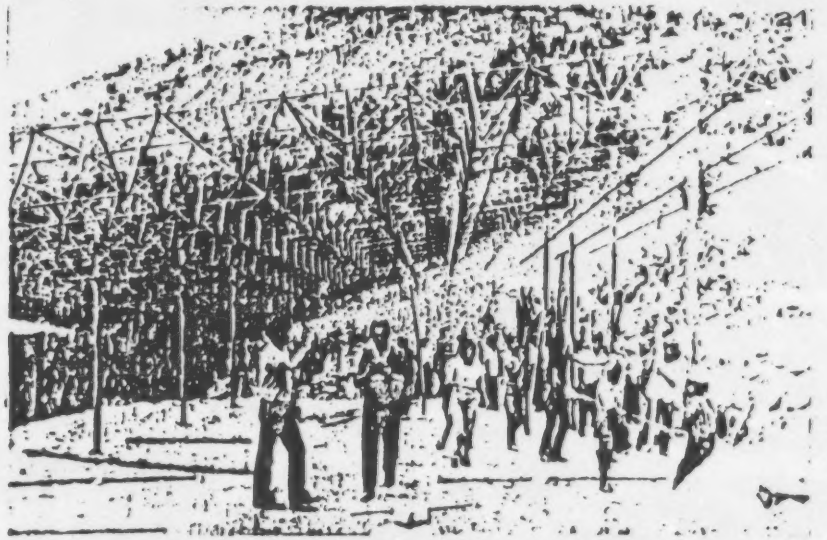
ARMADO...
STRUCTURE BUILDING
HOISTING

18

18. FASE DEL IZADO.

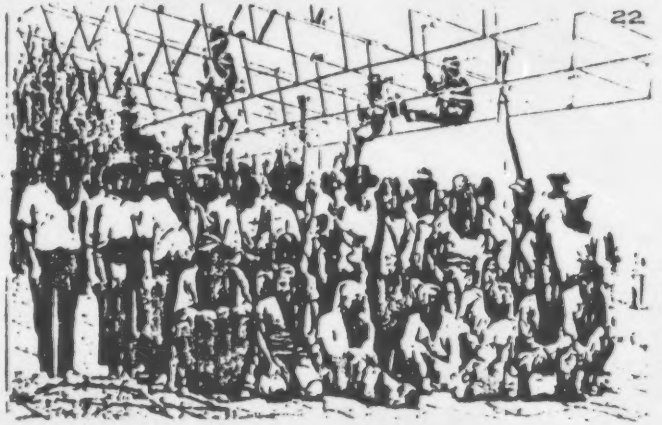


19. ENSAMBLE DE COLUMNA-CAPITEL


21

19

20.21. APLOMADO Y AJUSTES FINALES.


22

22. "LA FOTO DEL RECUERDO".

F. 11

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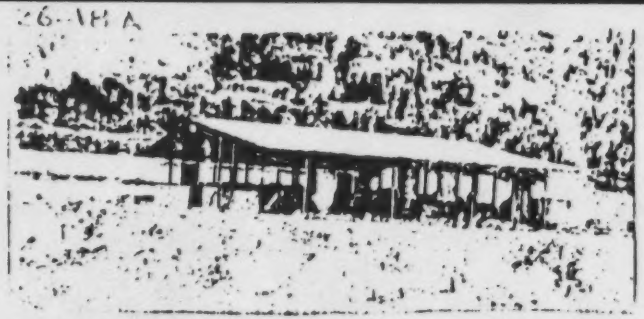
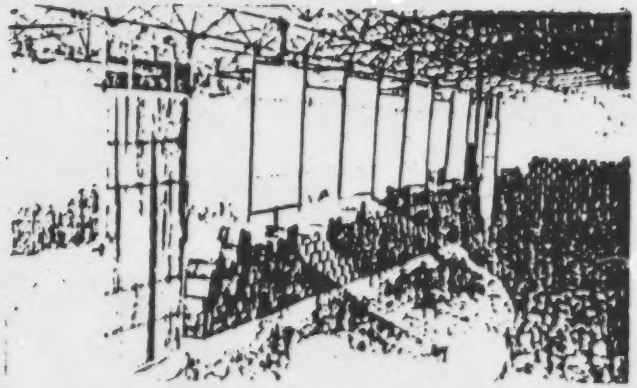


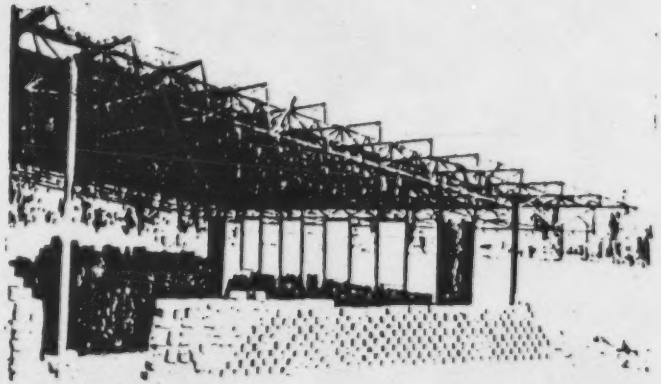


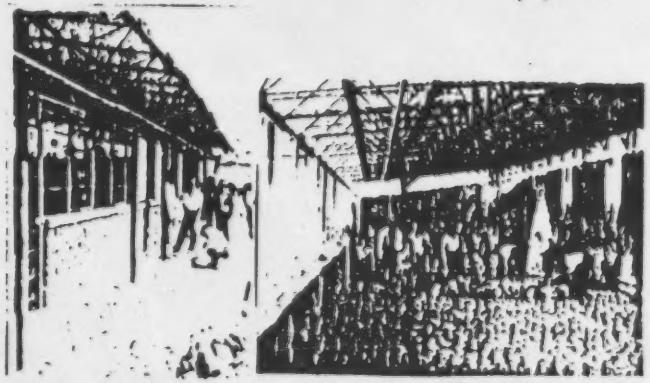
FASE DE TERMINACION:

(UTILIZACION DE TÉCNICAS LOCALES).

FINISHING

(USING LOCAL TECHNIQUES)





F. 12

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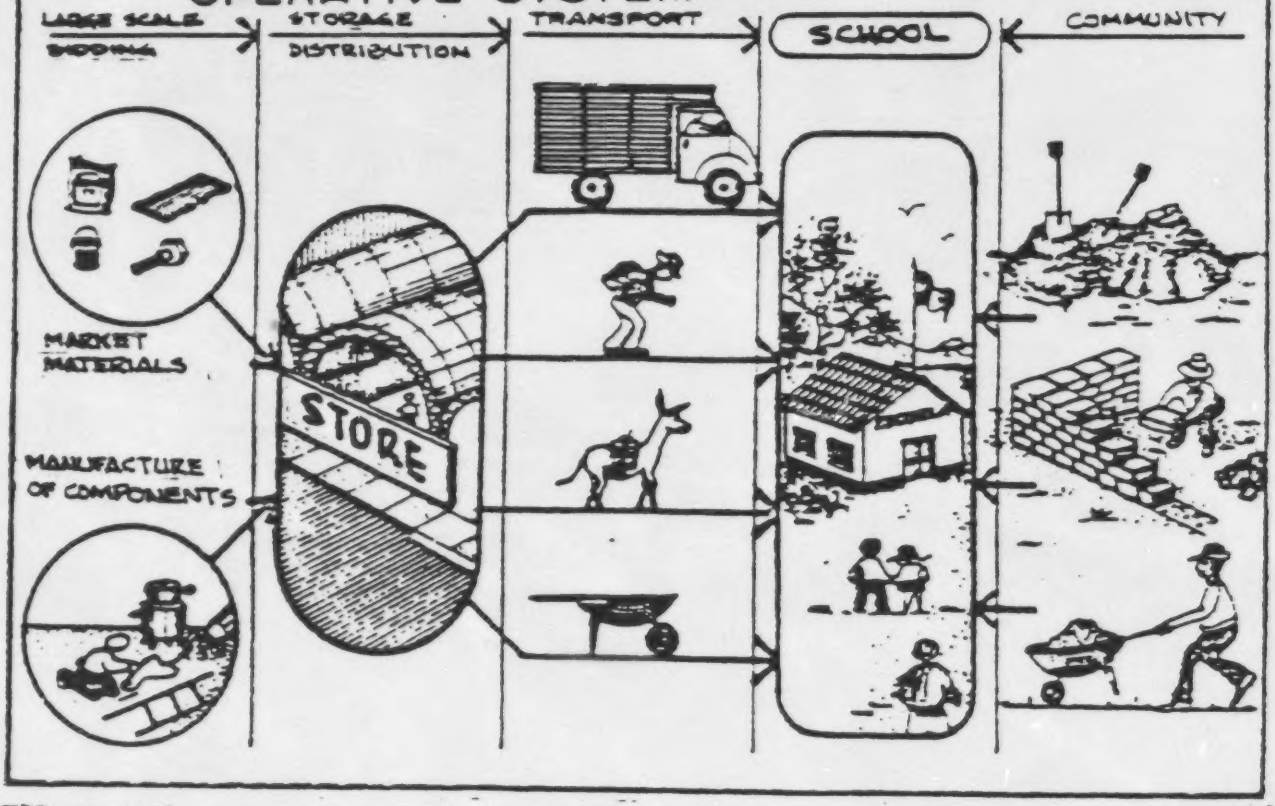
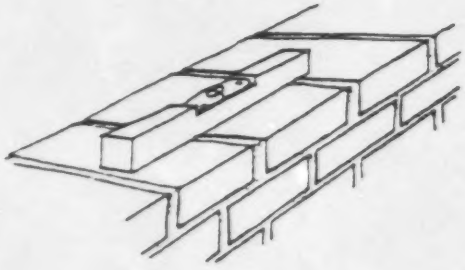
D – EN SISTEMA OPERATIVO :
OPERATIVE SYSTEM

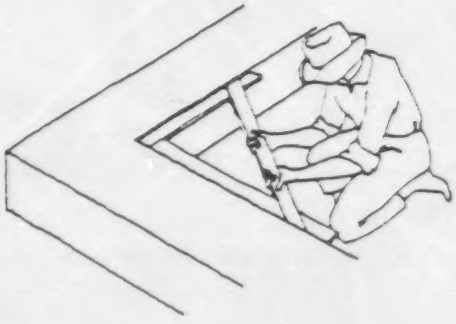


Finishing Handbook

Check that all your plane surfaces are perfectly level

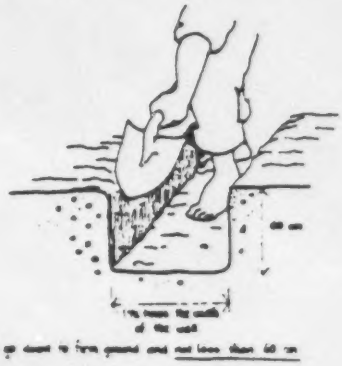


and your corners at right angles to each other.

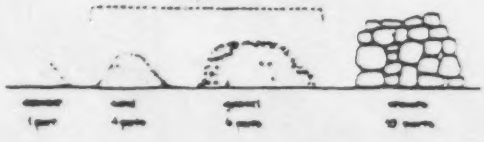


Finishing Handbook

Foundation trenches should be at least 1½ times as wide as the wall.



Footings should be made in concrete.



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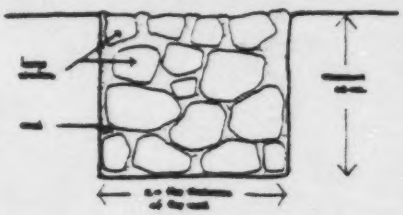
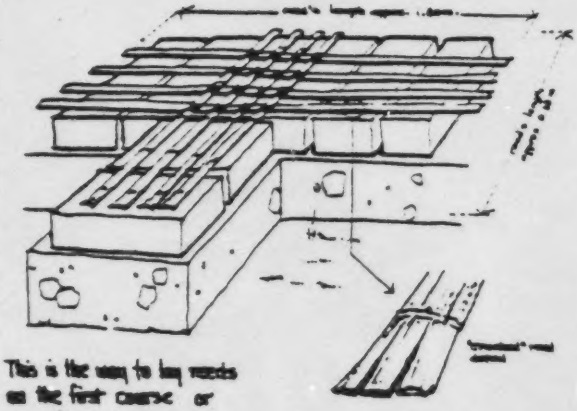
Finishing Handbook

Lime may be used if cement is not available and as a last resource you can even build foundations with lumps stones set in mud, as long as foundations are twice as wide as the walls and not less than 60 cm deep.



Finishing Handbook

DETAIL 1



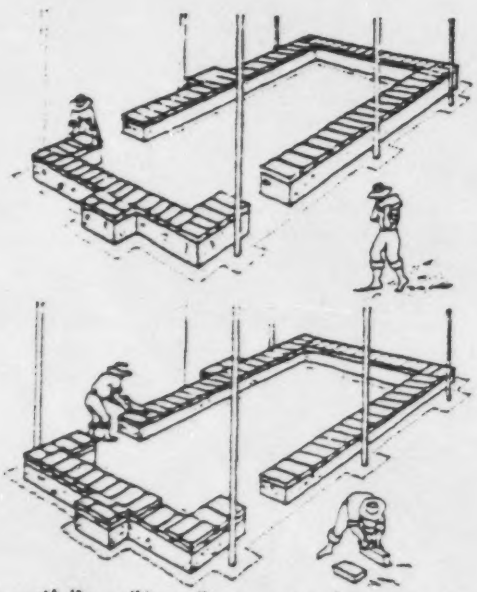
This is the way to lay blocks as the first course or as a typical course.

NOTE:

- Whenever possible, blocks should be laid together when they overlap.
- Four "crossed" blocks should be laid each way.
- Blocks must be fully embedded in mud mortar: a first layer of mud approximately 1 cm. thick is laid, the mud is pressed on it, then another layer of mud approximately 1.5 cm. thick is laid over it.

Finishing Handbook

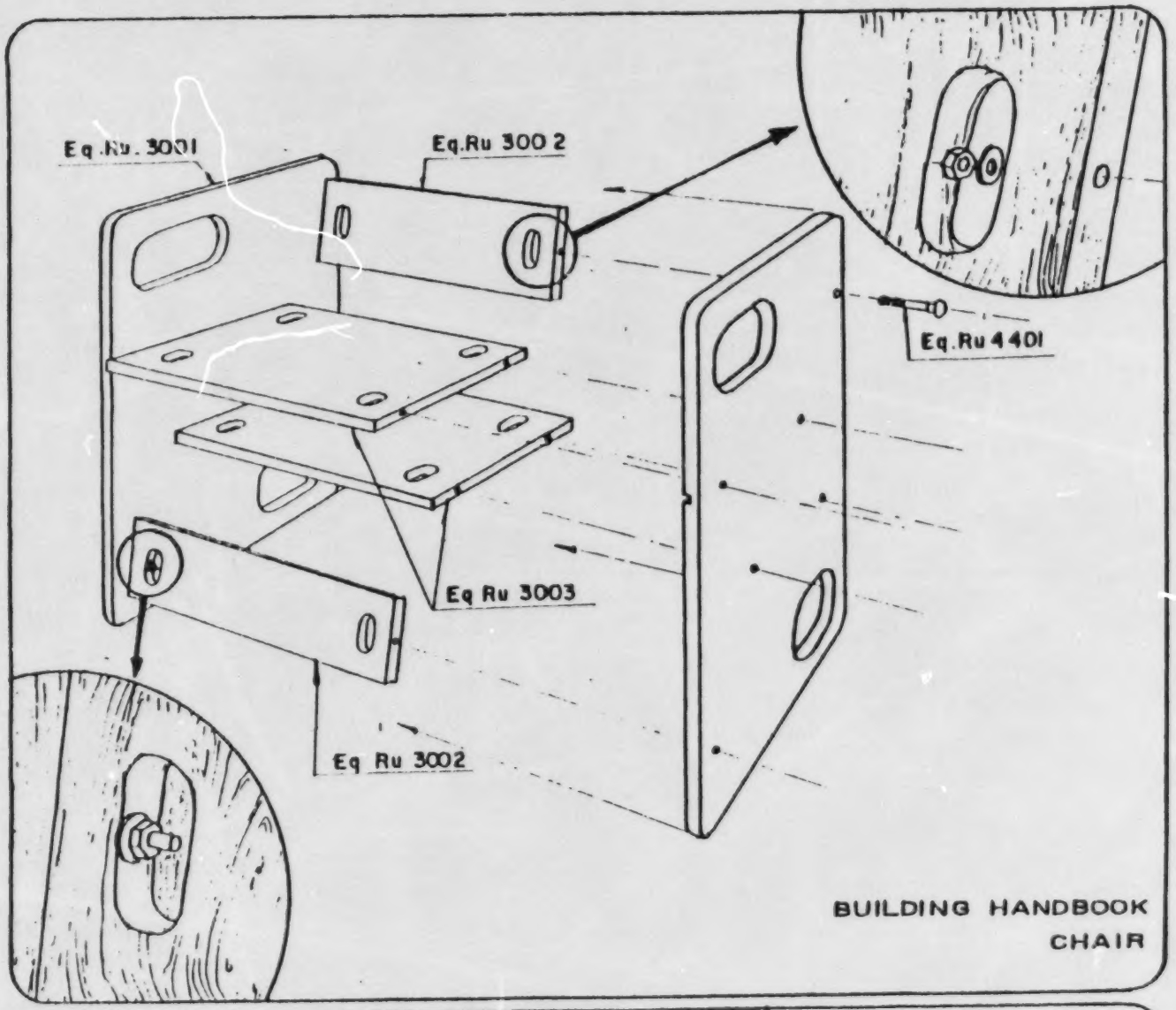
Adobes are laid in horizontal courses following the general outline of the school, so that the building grows evenly.



To avoid the wall's collapse under its own weight, you mustn't put up more than one meter high of wall each day.

Finishing Handbook

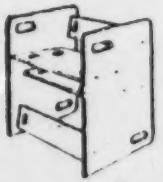
Walls should be rendered provisionally with mud, later with plaster.

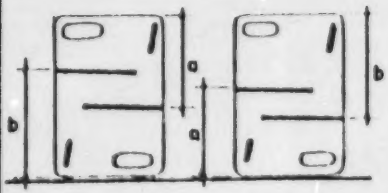


BUILDING HANDBOOK
CHAIR

	CANTIDAD	8	8	8	12	1
REQUERIMIENTO	COMPONENTE	Eq·Ru 3001	Eq·Ru 3002	Eq·Ru 3003	Eq·Ru 4401	Llave de boca de 1/2"

TEACHER/PUPIL
CHAIR





TWO SITTING HEIGHTS

ASSEMBLY
HANDBOOK

Eq
Ru

F.15

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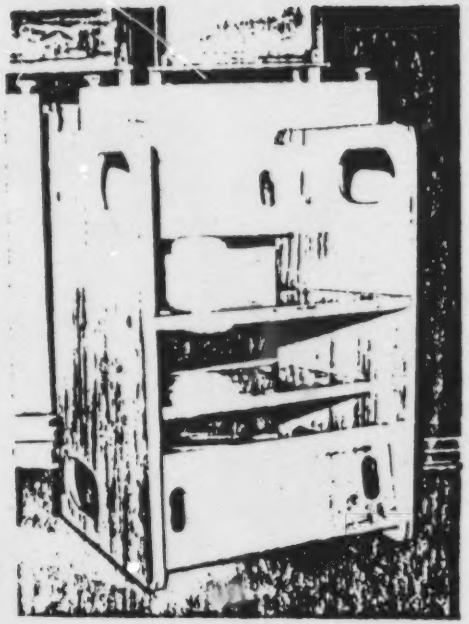
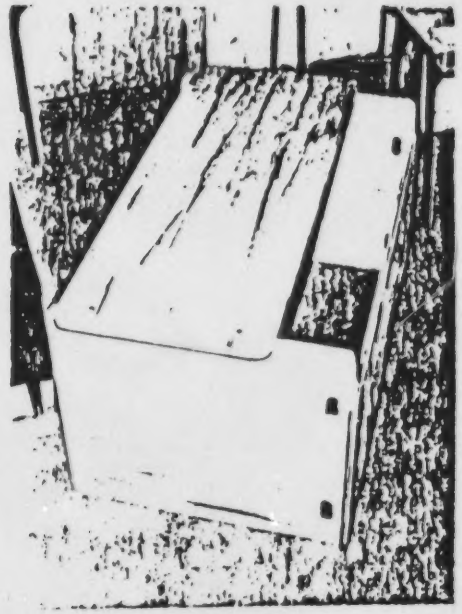
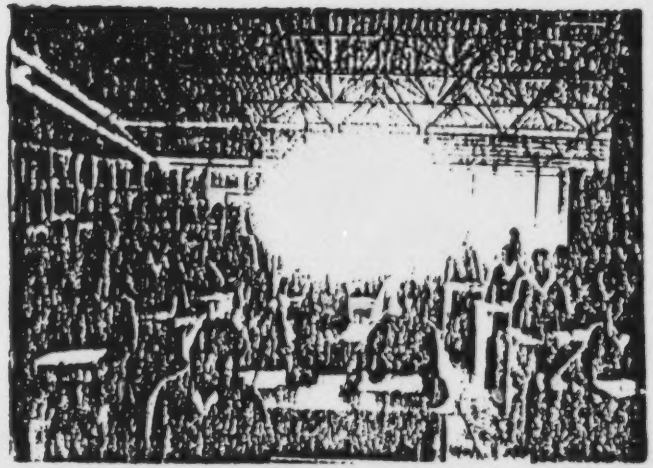




EL MOBILIARIO
FURNITURE

F. 16



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SERP PROJECT (SIERRA TYPE)

CHASQUI, FRONTIER & ORDEZA OPERATIONAL AREAS

	No. OF SCHOOLS	No. OF MODULES	COVERED AREA - M²
FRONTIER PROJECT F-1	22	100	3330
SERP ORDEZA PROJECT	38*	132	4356
CHASQUI 1 PROJECT	341	2125	70125
CHASQUI 2-3-4 PROJECTS	101	420	13860
FRONTIER F-4b PROJECT	11	73	2409
FRONTIER F-4a PROJECT	14	72	2376
TOTALS to 1977	**532**	**2922**	**96426**

(* approximate figure)

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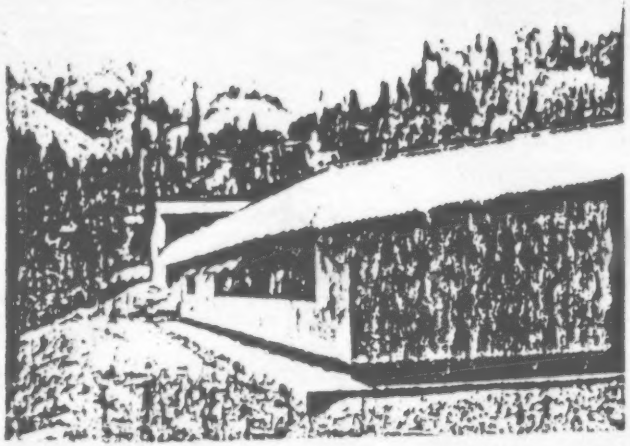

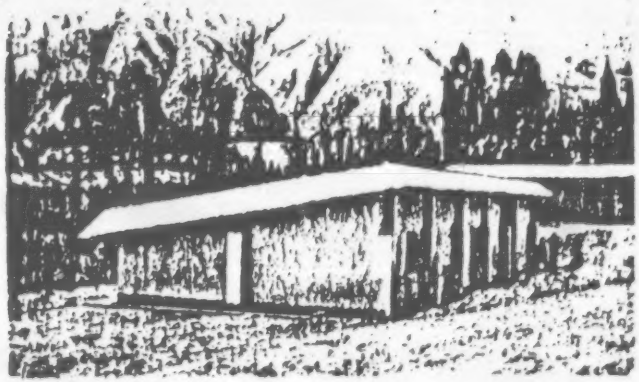

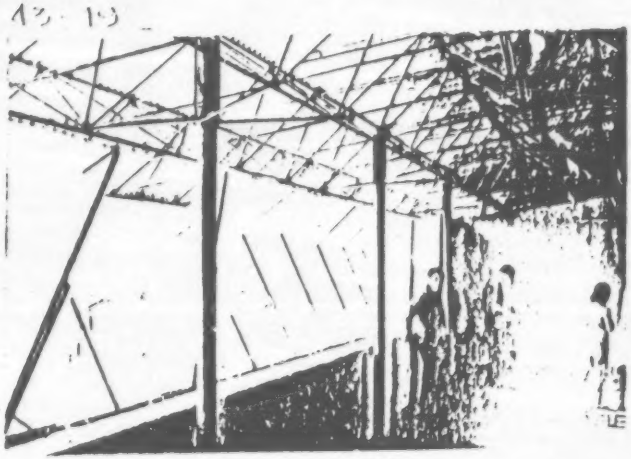

EXPERIMENTACION DE CAMPO:
PRIMER PROGRAMA DE APLICACION
"PLAN SUECIA".

FIELD EXPERIMENTATION :
FIRST APPLICATION PROGRAM "PLAN SUECIA"

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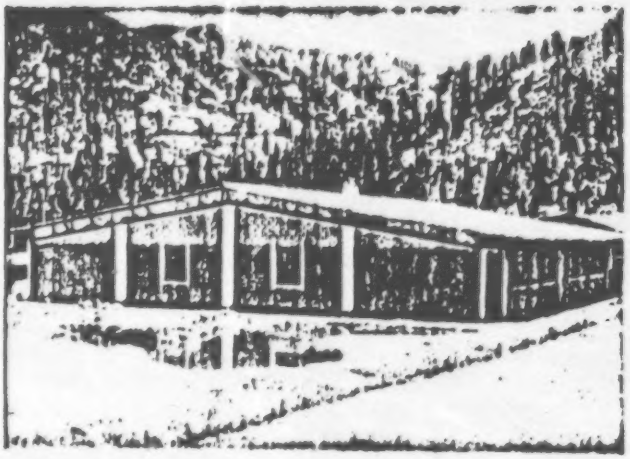
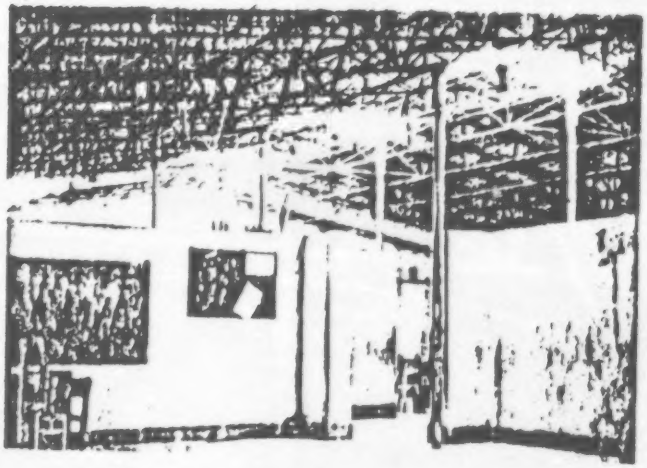
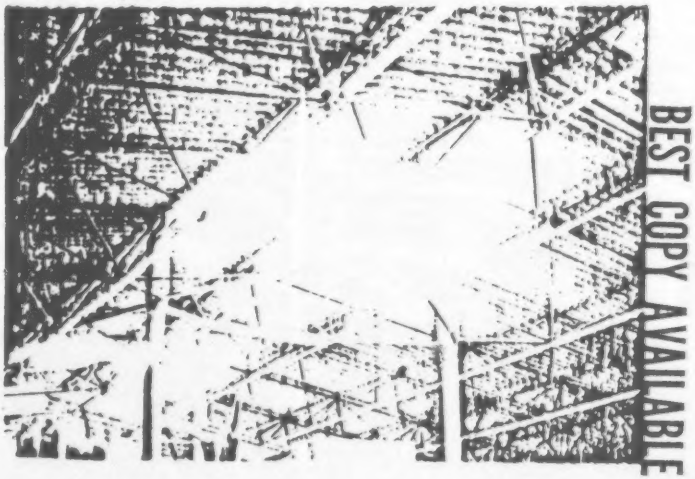


ESCUELAS TERMINADAS: TIPO-2CRUJIAS.
FINISHED SCHOOLS: 2 AISLES





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F.20